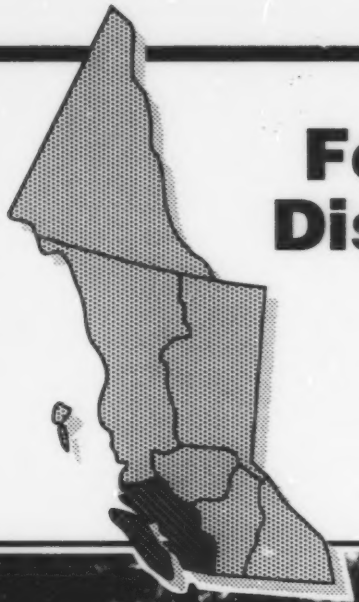
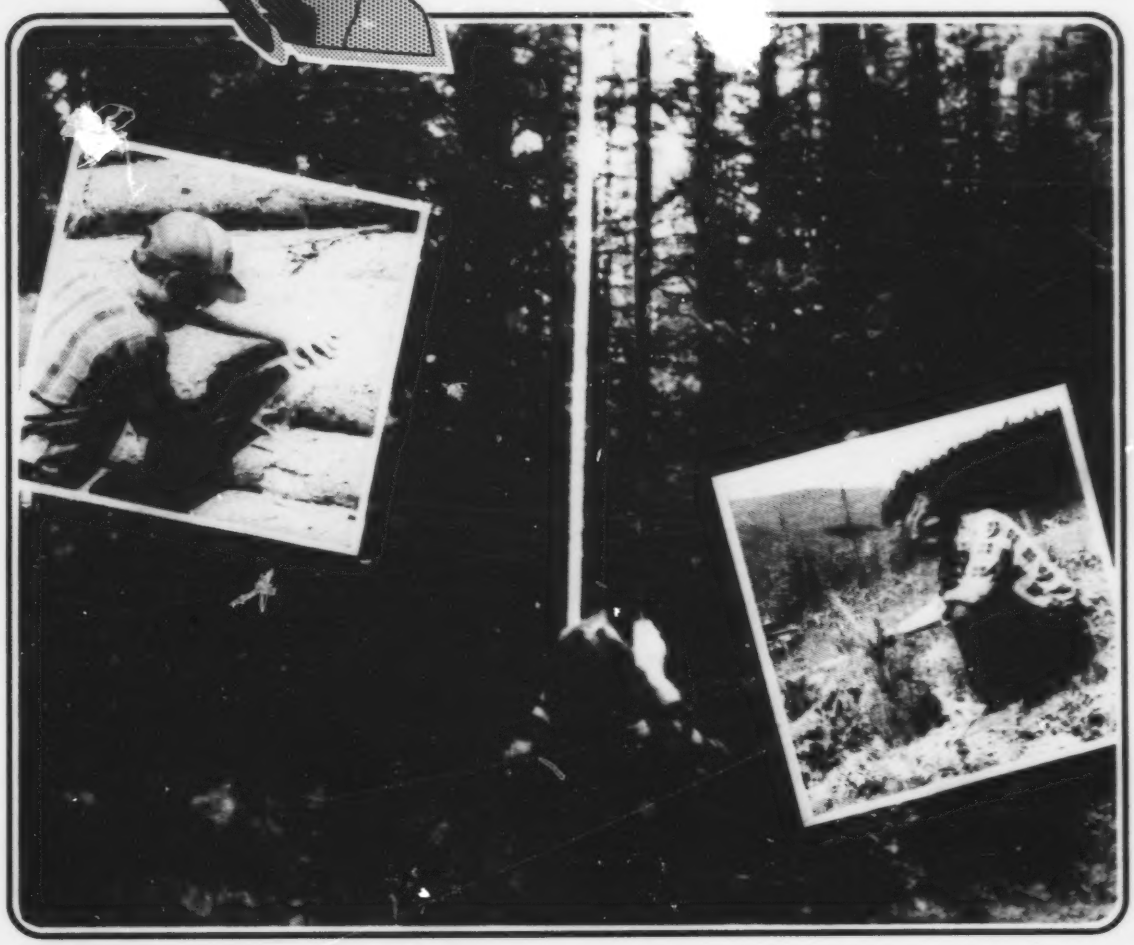
FIDS Report 91 - 6



Forest Insect and Disease Conditions

Vancouver Forest Region
1990

N. Humphreys & D.H.L. Clarke



Forestry Canada Forêts Canada

93-01366/

TABLE OF CONTENTS

	PAGE
INTRODUCTION	1
SUMMARY	3
DOUGLAS FIR PESTS	6
Western spruce budworm	6
Douglas-fir beetle	9
Douglas-fir tussock moth	10
Animal damage	10
PINE PESTS	11
Mountain pine beetle	11
Pine needle sheathminer	13
European pine shoot moth	14
A pine needle cast	14
A pine sawfly	14
A weevil	15
Porcupine damage	15
HEMLOCK PESTS	15
Western blackheaded budworm	15
Hemlock sawfly	17
Sirococcus shoot blight	17
TRUE FIR PESTS	17
Western balsam bark beetle-fungus complex	17
Balsam woolly adelgid	18
A balsam shoot boring sawfly	19
SPRUCE PESTS	20
Spruce beetle	20
Spruce weevil	20
Spruce aphid	20
Spruce bud necrosis	20
Cooley spruce gall adelgid	21
Spruce needle cast	21
CEDAR PESTS	22
Yellow cedar mortality	22
Cedar leaf blight	22
Cedar flagging	22
SPECIAL SURVEYS	23
Pinewood nematode	23
Seed orchards	31
Acid rain plots	32
Fume damage	33
MULTIPLE HOST PESTS	34
Pests of young stands	34
Vole damage	36
Gypsy moth	36
Winter damage	38
Conifer seedling weevil	39

PAGE

DECIDUOUS PESTS 39
Western winter moth 39
Winter moth, Bruce spanworm 40
Western tent caterpillar 41
Forest tent caterpillar 41
A bud midge 41
An oak leaf phylloxeran, Jumping gall wasp ... 41
Fall webworm 43
Poplar and willow borer 43
Birch leafminers 43
Broadleaf maple dieback 44
Dogwood leaf blight 44
MINOR PESTS 45
NEW RECORDS OF OCCURRENCE AND DISTRIBUTION 46

APPENDICES

The following appendices are available upon request from the Forest Insect and Disease Survey, Forestry Canada, 506 West Burnside Road, Victoria, B.C. V8Z 1M5.

I. Forestry Canada, Forest Insect and Disease Survey, Seed Orchard Examination Report Summary - 1990.

II. Forest Pest Conditions in Pacific Rim National Park, 1990.

III. Forest Pest Conditions on the Gulf Islands, 1990.

IV. Pest Conditions at Mt. Maxwell Eco Reserve, 1990.

V. Forest Pest Conditions at Carnation Creek, 1990.

VI. Forest Pest Conditions at Shawnigan Experimental Plots, 1990.

VII. Aerial Survey with MacMillan Bloedel Ltd., 1990.

VIII. Status of Forest Pests in Provincial Parks in the Vancouver Forest Region, 1990.

IX. Status of Forest Pests in the Vancouver Watersheds, 1990.

X. Status of Western Hemlock in Study Plots Defoliated by the Western Blackheaded Budworm and the Hemlock Sawfly, 1984-1988, Queen Charlotte Islands, 1989.

INTRODUCTION

This report outlines the status of forest pest conditions in the Vancouver Forest Region for 1990 and forecasts population trends of some potentially damaging pests. Pests are listed by host in order of importance.

The Forest Insect and Disease Survey (FIDS) is a nation-wide network within Forestry Canada with the responsibility of producing an overview of forest pest conditions and their implications; maintaining records and surveys to support quarantine and facilitate predictions; supporting forestry research with records, insect collections and herbaria; providing advice on forest insect and disease conditions; developing and testing survey techniques; conducting related biological studies and analyzing this year's and previous year's data and producing various pest information maps using the in-house Geographical Information System (GIS).

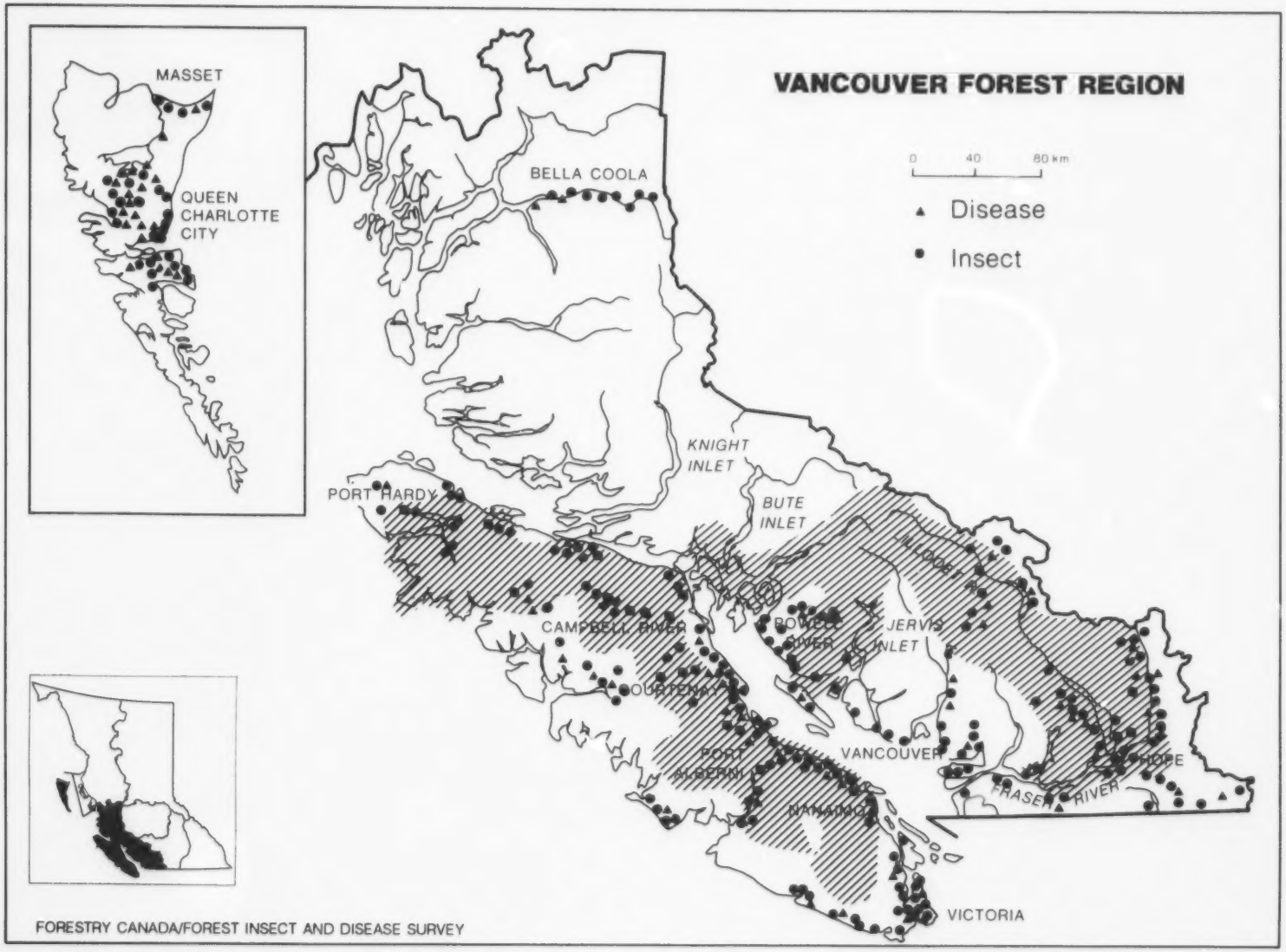
Annual surveys of the Queen Charlotte Islands to assess forest disease and defoliator damage were conducted by Prince Rupert Supervising FIDS Ranger, Rod Garbutt, from August 1st to 12th. Insect and disease data from the mid-coast Forest District were collected by the Cariboo FIDS Ranger, Bob Erickson.

The forest pest survey field season extended from mid-May to early October. A total of 490 insect and 160 disease collections were submitted to Pacific Forestry Centre by FIDS survey personnel. Map 1 shows the locations where one or more samples were collected and the areas covered by 24 hours of fixed-wing aircraft surveys and 11 hours of helicopter surveys. A total of 13 special collections included western winter moth, winter moth, pine sawfly, blackheaded budworm, and diseases and insects of weed species.

Numerous special surveys were conducted including inspections of provincial parks, ecological reserves and seed orchards, acid rain plot monitoring, spruce budworm and gypsy moth pheromone trapping, young stand surveys, root disease surveys, European pine shoot moth quarantine surveys, fume damage plot assessment, pinewood nematode surveys and public/industry extension calls.

Personnel of the B.C. Forest Service, MacMillan Bloedel Ltd., Fletcher Challenge Canada Ltd., Western Forest Products Ltd., and Scott Paper Ltd. assisted with ground and air transportation and with defoliator larval and egg sampling. Defoliation intensities in the report are defined as follows:

Trace - evidence of feeding barely detectable close up
Light - some branch and/or upper crown defoliation, barely visible from the air
Moderate - pronounced discoloration and noticeably thin foliage, severe top defoliation
Severe - top and many branches completely defoliated, most trees more than 50% defoliated



Map 1. Locations where one or more forest insect and disease samples were collected and areas covered by aerial surveys to map bark beetle and defoliator infestations in 1990.

SUMMARY

Western spruce budworm lightly to moderately defoliated Douglas-fir over 3825 ha in the Birkenhead Lake-Blackwater Creek area, down from 4885 ha in 1989. Seven percent of the trees were top-killed. The area of mature Douglas-fir killed by **Douglas-fir beetle** attacks increased for the second consecutive year to 330 ha from 174 ha in 1989 and 37 ha in 1988, mostly in the Interior Douglas-fir biogeoclimatic zone near Pemberton and Boston Bar. A new outbreak of **Douglas-fir tussock moth** moderately and severely defoliated scattered pockets of Douglas-fir from Abbotsford to near Chilliwack, where defoliation last occurred in 1983. **Black bears** girdled and damaged semimature Douglas-fir over several hundred hectares in the Sowaqua Creek drainage east of Hope. Clipping of terminal and lateral buds by **blue grouse** was recorded at several locations in the Region.

Mountain pine beetle killed an estimated 8200 lodgepole pine over 540 ha in 64 infestations, a decrease from 14 000 trees over 545 ha in 53 infestations in 1989. The **pine needle sheathminer** defoliated young lodgepole pine over widespread areas on the mainland for the fourth consecutive year. **European pine shoot moth** infested three Douglas-fir shoots at a Christmas tree plantation near Richmond. The moth was first found on Douglas-fir in North America in 1989, in the same plantation. A **pine sawfly** severely defoliated 15- to 20-year-old lodgepole pine over a 15-ha plantation at Spuzzum Creek northwest of Yale, for the second consecutive year. A **broad-nosed weevil** defoliated western white pine over a wide area on Texada Island and the Sunshine Coast, also for the second consecutive year. **Porcupines** continued to debark about 5% of the 10- to 15-year-old lodgepole pine over 10 ha at both 9 Mile of the Uztlius Creek road and at 13 Mile of the Mowhokam Creek main road.

The **western blackheaded budworm** defoliated 630 ha of western hemlock on northern Vancouver Island, down from 7400 ha in 1989. About 22% of the trees in two areas were top-killed. **Sirococcus shoot blight** killed new tips of immature hemlock at several widespread locations in the host range.

The **balsam bark beetle** in conjunction with a pathogenic fungus killed mature alpine fir in more than 140 scattered areas, mostly in the Fraser TSA over 1385 ha, up from 1165 ha in 1989. Active populations of the **balsam woolly adelgid** were recorded at several locations in the Region, possibly causing 150 ha of balsam mortality near Port Alberni, within the quarantine zone. Small populations, but little damage, were found for the first time on Hornby Island, outside the quarantine zone. New shoots were killed by a **balsam shoot boring sawfly** for the third consecutive year in high-elevation immature balsam stands throughout the Vancouver Mainland district.

For the fourth consecutive year, **spruce beetle** populations declined with no areas of beetle mortality noted. The **spruce weevil** continued to cause significant leader mortality of Sitka spruce throughout the host's range. This has prevented adequate reforestation in some parts of the Region. Defoliation of spruce trees by the **spruce aphid** increased dramatically in the Region this year, causing extensive severe defoliation and some mortality of natural and ornamental spruce. **Spruce bud necrosis** from unknown causes was widespread on the Queen Charlotte Islands. The **Cooley spruce gall adelgid** was collected for the first time on the Queen Charlotte Islands infesting more than 80% of the needles of six ornamental Douglas-fir near Queen Charlotte City. A **spruce**

needle cast infested sapling-sized planted and natural Sitka Spruce at widespread locations on Vancouver Island and the Queen Charlottes, resulting in premature needle loss.

Individual and small patches of **dead yellow cedar** were seen on primarily the eastern slopes of Moresby and Louise islands and on western Graham Island. Infections by the **cedar leaf blight** have increased this year causing widespread foliage discoloration of western red cedar, mainly in overstocked stands. Highly visible **flagging** of western red cedar foliage is evident throughout the Pemberton Valley and along Birkenhead and Green rivers.

Special surveys completed in the Region in 1990 included the examination of more than 1300 logs, 61 live trees and 11 samples of manufactured wood, examined for evidence of insects which could potentially vector pinewood nematode. None contained the nematode. Eleven seed orchards were surveyed two or more times for early detection of pests, some of which were **balsam woolly adelgid, Cooley spruce gall adelgid** and **Douglas-fir cone moth. Tree mortality** resulting from competition and shading out has occurred in 9 of the 10 ARNEWS (Acid Rain National Early Warning System) study plots in the Region. **Fume damage** continues to damage trees within 2 km of the Port Alice pulp mill.

A total of 30 natural and planted stands were surveyed for pest problems, some of which were **deer browse, voles, balsam shoot boring sawfly and winter kill. Meadow voles** killed up to 100% of newly planted seedlings in the Pemberton area at several plantations. **Gypsy moth** pheromone-baited traps were placed at 150 locations surveyed by FIDS, but no moths were caught. However, 120 males, 12 females, 14 pupal cases, and 37 egg masses have been collected in the Region, mostly at Saanichton, by Agriculture Canada. Severe **winter winds** in 1989 defoliated mature conifers near Bella Coola, but the extent of mortality will not be known until the completion of surveys in 1991. A **conifer seedling weevil** killed 20% of newly planted Sitka spruce seedlings and partially girdled 80% of the remainder over 5 ha on Graham Island.

Defoliation of deciduous hosts by the **western winter moth** decreased substantially in the Fraser Valley. **Winter moth** defoliation increased for the first time in several years, damaging various deciduous trees and shrubs in the Victoria and Vancouver areas. The **Bruce spanworm** was active in some areas of the lower mainland. Populations of the **western** and **forest tent caterpillar** have remained at endemic levels for the last two years. A **bud midge** caused widespread bud mortality on black cottonwood on the southern coast this year. Increased populations of **oak leaf phylloxerans** and **jumping gall wasps** caused premature browning and early defoliation of Garry oak on southeastern Vancouver Island. The **fall webworm** defoliated hardwood trees throughout the Chilliwack and Agassiz area and on southeastern Vancouver Island. **Poplar-willow borer** attacked willow and poplar throughout the hosts range in the Region. **Birch leafminers** caused extensive defoliation of natural and exotic birch in widespread scattered areas on the lower mainland. Broadleaf **maple dieback** or **leaf scorch** continued on scattered roadside and open growing trees throughout the host range in the Region. **Dogwood leaf blight** continued to cause defoliation of western flowering dogwood throughout the host range, causing premature leaf loss and twig and branch mortality.

Collections made and records of many pests currently at endemic levels, i.e., **Swiss needle cast, western gall rust, spruce budmoth, green-striped forest looper** and other insects and diseases are included in the Minor Pests section of this region. New records of occurrence and distribution of pests have also been included in this report.

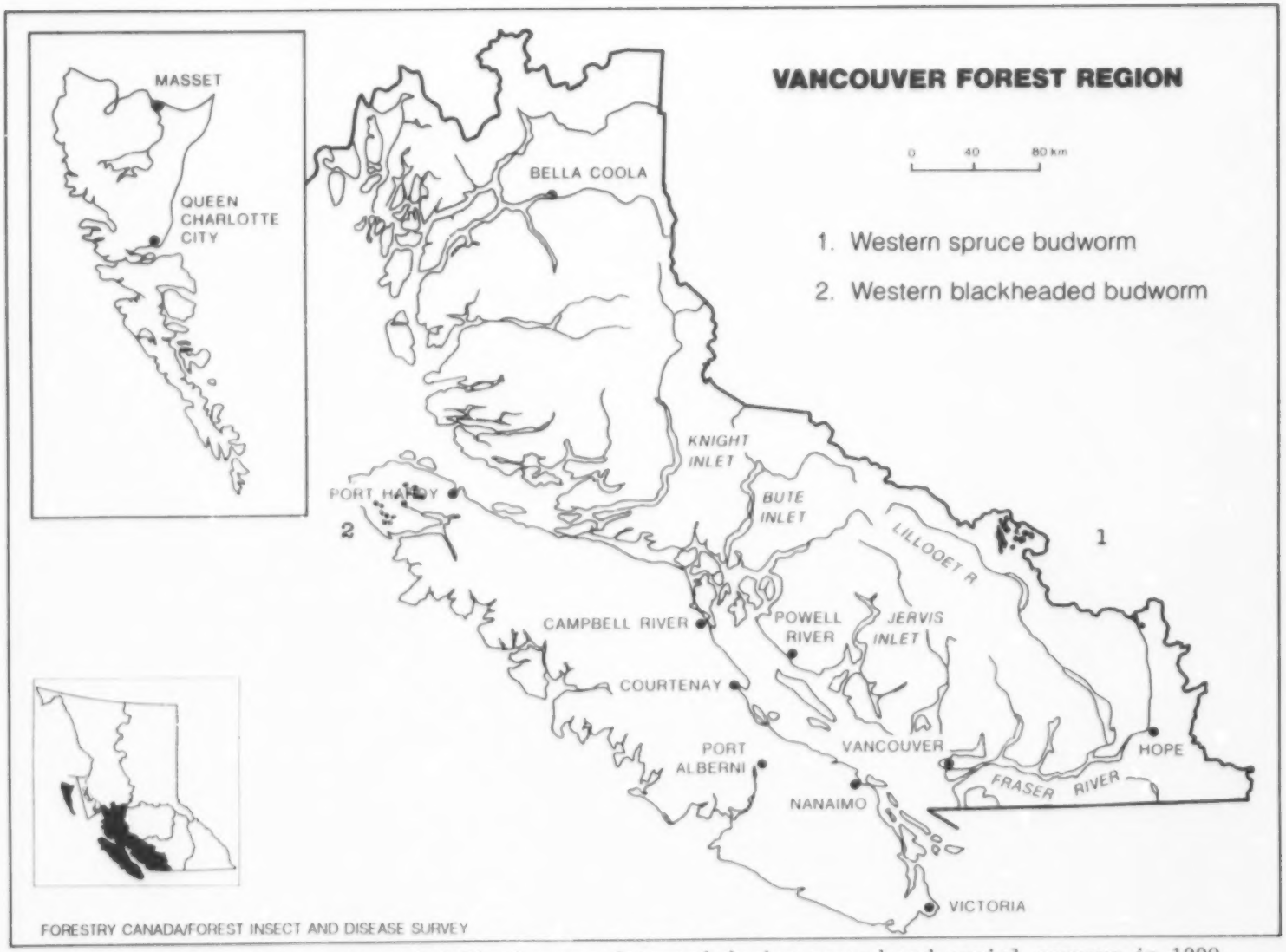
Western spruce budworm
Choristoneura occidentalis

For the first time in five years the area of western spruce budworm-damaged Douglas-fir decreased to 3826 ha from 4885 in 1989, in 23 pockets east of Pemberton and near Keefers north of Boston Bar, in the Soo and Fraser TSAs, respectively (Map 2).

Budworm populations continued to move westward from the Haylmore-Blackwater and Phelix-Sockeye Creek drainages into the Birkenhead and Gates River drainages. While the area of light defoliation increased this year to 3590 ha from 2760 ha, the area of moderate defoliation decreased to 235 ha from 2125 ha. The major area of decline occurred in the Haylmore-Blackwater-Phelix Creek drainages to 1470 ha of light-moderate defoliation from 4480 ha. The locations in the Soo TSA where the area of defoliation increased were in the Birkenhead Lake-River drainage to 935 ha from 200 ha and along the Gates River where 1075 ha of light defoliation were recorded compared to none in 1989. The one 30-ha light infestation recorded in the Fraser TSA at Keefers north of Boston Bar expanded in 1990 to three infestations covering an estimated 180 ha and an additional 65 ha of light infestation at Ainslie Creek, 10 km southeast of Keefers.

Table 1. Timber supply area, location, area and intensity of Douglas-fir defoliation by western spruce budworm, as determined from aerial surveys, Vancouver Forest Region, 1990 and 1989.

TSA and Location	Area of defoliation (ha)							
	Light		Moderate		Severe		Total	
	1990	1989	**1990**	1989	**1990**	1989	**1990**	1989
SOO TSA								
Birkenhead R.	**700**	-	**235**	200	-	-	**935**	200
Haylmore Cr.	**450**	850	-	-	-	-	**450**	850
Phelix Cr.	**220**	700	-	700	-	-	**220**	1400
N. Blackwater Cr.	**150**	530	-	-	-	-	**150**	530
Sockeye Cr.	**100**	-	-	175		-	**100**	175
S. Blackwater Cr.	**650**	650	-	1050	-	-	**650**	1700
Gates R.	**1075**	-	-	-	-	-	**1075**	-
FRASER TSA								
Hannah Cr.	180	30	-	-	-	-	**180**	30
Ainslie Cr.	65	-	-	-	-	-	**65**	-
Total	**3590**	2760	**235**	2125	-	-	**3825**	4885



Map 2. Areas where current defoliation was detected during ground and aerial surveys in 1990.

An increase in the amount of top-kill on mature Douglas-fir trees occurred in drainages where defoliation has been recorded for three or more years, mostly in the Soo TSA, including Haylmore, Blackwater and Phelix creeks. Dead tops up to 3 m in length were noted on approximately 7% of the trees in all areas, up from less than 5% in 1989. Based on previous years outbreaks, top-kill will probably increase over the next few years even after the infestation subsides. Defoliated trees will continue to suffer growth loss which, from increment cores taken in 1989, was determined to be an average 12% increment reduction during years of light and moderate defoliation.

The number of egg masses collected at four locations within infested areas near Pemberton averaged 112 egg masses/10 m^2 of foliage (range 38-236), up 20% from an average of 93 (range 0-227) in 1989 (Table 2). Moderate defoliation can be expected in most areas next year.

Table 2. Location, average number of western spruce budworm egg masses collected, increase, decrease and predicted defoliation for 1991, Vancouver Forest Region, 1990.

Location	Avg. no. of egg masses/10 m^2 of foliage/plot		percent increase/ decrease	Defoliation*	
	1990	1989		1990	1991(predicted)
S. Fowl Creek	236	227	+ 4	Moderate	Mod-Severe
N. Fowl Creek	93	-	new	Moderate	Moderate
N. Blackwater Creek	38	64	- 41	Light	Light
S. Blackwater Creek	81	54	+ 50	Light-Mod	Moderate
Average	112	93	+ 20		

*1-50 egg masses/10 m^2 - Light defoliation: discolored foliage barely visible from the air, some branch tip and upper crown defoliation.

51-150 egg masses/10 m^2 - Moderate defoliation: pronounced discoloration, noticeably thin foliage, top third of many trees severely defoliated, some completely stripped.

151+ egg masses/10 m^2 - Severe defoliation: bare branch tips and completely defoliated tops, most trees more than 50% defoliated.

The number of egg masses decreased by an average of 41% in one location and increased by an average of 13% in two locations in 1990. The highest number, 236 egg masses, were collected south of Fowl Creek along the Birkenhead River where moderate defoliation was visible during aerial surveys. The infestation appears to be continuing in the Blackwater Creek and Birkenhead River areas, but no feeding has yet been noted to the west in the Railroad Creek and adjoining drainages where historically the budworm has expanded after several years of build-up in the Birkenhead region. No egg mass collecting was attempted in the Fraser TSA at Hannah or Mowhokam creeks due to the inaccessibility of the sites.

A project started in 1987 to detect increasing budworm populations continued in 1990. Pheromone-baited dry "Multipher" traps (5/site) were placed in each of four areas of previous infestations, Devine, Skagit Valley, North Bend and in the Anderson River drainage, to attract male adults (Table 3). Calibrating the traps to relate the number of moths, larvae and defoliation is still in progress and will probably take several more years before reliable predictions can be made from either larvae or adult male moth numbers.

Table 3. Location, number of larvae/tree, number of adult male moths/trap and degree of defoliation at four spruce budworm pheromone calibration plots in the Vancouver Forest Region, 1990.

Location	Avg. no. larvae/tree		Avg. no. moths/trap		Total tree defoliation at plots	
	1990	1989	1990	1989	1990	1989
Devine	7.4	16.7	128	570	light	light
North Bend	.5	0	28	141	none	none
Anderson R.	1.3	0	12	57	none	none
Skagit Valley	0	0	6	18	none	none

Male moth numbers decreased at all four locations in 1990 with a 70 to 80% reduction at Devine, North Bend, Anderson River and Skagit Valley. In contrast, larval numbers increased slightly at North Bend and Anderson River, but decreased by 50% at Devine. The reduction in larval numbers at Devine corresponds with the decrease in budworm egg masses at the nearby North Blackwater Creek egg mass collection site. Budworm populations will continue to be monitored in 1991.

Douglas-fir beetle
Dendroctonus pseudotsugae

For the second consecutive year the area of Douglas-fir beetle recently killed by beetle attacks increased to 330 ha from 174 ha in 1989, and 37 ha in 1988, mostly in the Interior Douglas-fir biogeoclimatic zone near Pemberton and Boston Bar.

The majority of the increase occurred in the Fraser TSA, where 250 ha were mapped in 26 infestations compared with 57 ha over 13 infestations in 1989. Pockets of attacked trees ranged in size from 0.5 ha to 25 ha, mostly in the Anderson and east Anderson River drainages over 150 ha in 18 infestations. The remaining 55 ha were located in 6 infestations around the North Bend-Boston Bar area. Areas of attack were all of light intensity with only 2 to 20 newly attacked trees counted in even the larger infestations. In most areas of infestation the beetle has attacked trees weakened by the root rot, Phellinus weirii. The discoloured trees are evident around the periphery of root rot centers. The 26 ha of beetle-attacked trees that were mapped along the Chilliwack River and Maselpanik Creek in 1989 subsided with no new attack evident this year.

In the Soo TSA the area of beetle-attacked Douglas-fir increased to 125 ha of light attack over 17 infestations from 77 ha in 11 infestations in 1989, ranging in size from 0.5 ha to 26 ha. New infestations were mapped along the east side of Lillooet Lake in the Lizzie, Twin Two and Twin One Creek drainages. Mortality continued in the Billygoat, Ure and Gravell Creek drainages along the west side of Lillooet Lake. A 1989 fire at Haylmore Creek scorched and weakened Douglas-fir over approximately 20 ha, and all the trees were infested by Douglas-fir bark beetle this year. The broods in the infested trees will mature and fly next spring and summer, threatening adjacent stands.

The Douglas-fir beetle prefers hosts such as felled trees, slash, stumps, overmature trees and trees damaged by drought, root rot, logging and road building. Host material over 20-cm diameter is preferred.

Douglas fir tussock moth
Orgyia pseudotsugata

A new outbreak in the Fraser Valley caused moderate to severe defoliation of immature and mature Douglas-fir in scattered pockets along Highway 1 from Abbotsford to just west of Chilliwack. The most severe defoliation occurred at Clearbrook along the Highway and in residential properties. Damage to scattered individuals ranged from light defoliation of a few branches to about 40% of the crown defoliated. Previous outbreaks have occurred in the same general area in 1971-72 and in 1982-83. In 1983 the infestation expanded to include the Chilliwack Golf and Country Club west of Chilliwack.

Egg mass surveys on Douglas-fir trees at Vedder Canal and Clearbrook showed an average 2.2 egg masses per branch, range 0-4. There was an obvious correlation between defoliation and number of egg masses with the more heavily defoliated trees showing the greatest number of egg masses. Based on data which indicate defoliation will occur when the number of egg masses exceed 0.7 per branch, the infestation is forecast to continue in 1991, which will be confirmed by larval assessments in the spring and summer of 1991.

Animal damage

Black bears girdled and damaged young Douglas-fir in the 20- to 30-year-old class over several hundred hectares at the back end of Sowaqua Creek. The damage, the first seen in the Region in recent years, was confined to scattered trees from 25-50 cm DBH.

Bear damage has been observed for years on the Olympic Peninsula in Washington State, with up to 51% of the Douglas-fir injured over extensive areas of the South Olympic Tree Farm. It is usually open growing trees in understocked stands that sustain the most damage. Bears strip the bark from the trees with their claws and then scrape the exposed sapwood with the lower jaw which removes a pulpy mass of new wood. Feeding takes place in the spring and early summer months; a study of over 250 bears from the Olympic Peninsula found that sapwood of Douglas-fir was a major food item from April through July. The long canine teeth cause vertical grooves up to 1.5 m in length and the ragged top edge of the wound and discarded strips of bark are characteristic of bear damage. Basal girdling is more common than upper crown debarking. Bear feeding differs from damage by rodents which eat the bark and leave horizontal or diagonal tooth marks.

The **blue grouse** caused extensive bud and needle clipping of Douglas-fir and amabilis fir seedlings and saplings in young plantations in the Squamish River and Ashlu Creek drainages along the Sunshine Coast and on Southern Vancouver Island. Up to 42 and 25% of Douglas-fir and amabilis fir trees, respectively, were attacked with 100% of terminal buds eaten, less than 5% of the lateral buds were removed.

Bud and needle clipping as well as needles being entirely plucked from the stem are characteristic of grouse injuries. Seedlings can appear denuded or tufted when the remaining buds open. The clipping of small lateral shoots may resemble deer browsing. Douglas-fir foliage is a preferred food throughout the year and extensive clipping of the buds and needles impairs the vigor and height of young trees.

PINE PESTS

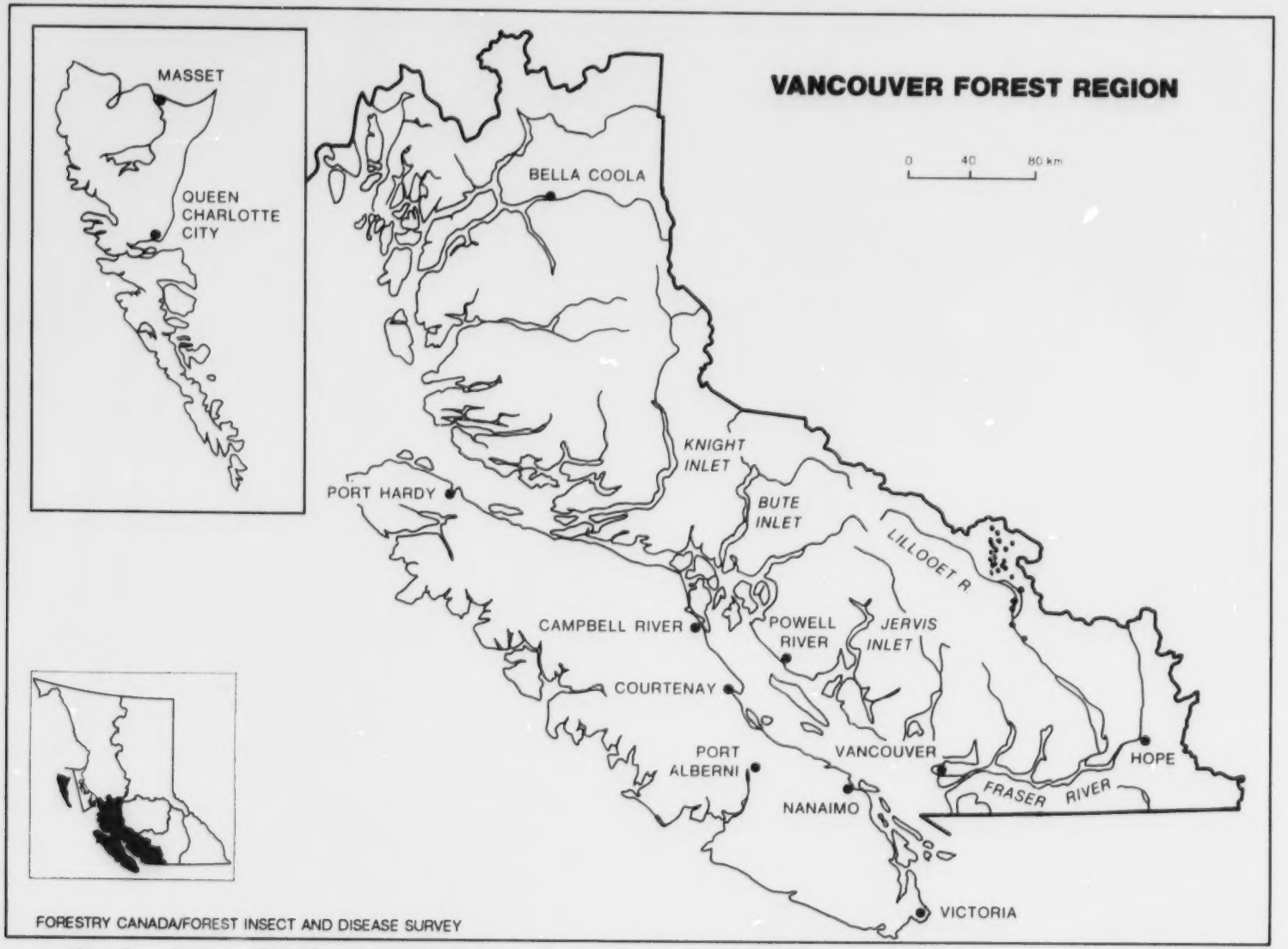
Mountain pine beetle
Dendroctonus ponderosae

Mountain pine beetle killed an estimated 8200 lodgepole pine over 540 ha in 64 infestations in 1990, a decrease from 14 000 trees over 545 ha in 53 infestations in 1989 (Table 4). This is the fourth consecutive year of decline from a recent high of 4160 ha of mortality in 176 infestations in 1986. Volume loss also declined to approximately 6000 m^3 from almost 10 000 m^3 last year due mainly to a decrease in the intensity and not the area of attack (Map 3).

Table 4. TSA, area, number and volume of pine trees recently killed by mountain pine beetle as determined from aerial surveys, Vancouver Forest Region, 1990.

TSA	Area (ha)		No. of trees killed		Vol. (m^3) killed		No. of infestations	
	1990	1989	1990	1989	1990	1989	1990	1989
Fraser	-	25	-	600	-	500	-	3
Soo	535	520	8 000	13 000	6 000	9 400	51	50
Mid-coast	5	-	200	-	150	-	13	-
Sunshine coast	-	-	-	-	-	-	-	-
TOTAL	**540**	**545**	**8 200**	**13 600**	**6 150**	**9 900**	**64**	**53**

Beetle ground cruises and surveys were not undertaken this year due to population decreases, host depletion and inaccessibility of sites.



Map 3. Areas of lodgepole pine recently killed by mountain pine beetle determined by aerial and ground surveys in 1990.

Fraser TSA

No infestations were recorded in the Fraser TSA in 1990 which is not unusual as only 25 ha were mapped in 1989, along the east side of the Fraser River between Hope and Squeah. This is largely a result of host depletion and harvesting of infested stands.

Soo TSA

In the Soo TSA the area of attack increased slightly to 535 ha from 520 ha but the intensity of attack decreased, with all areas classified as light infestation compared to 1989 when 26% of the infested stands were mapped as moderate mortality. Therefore, the area of attack increased by 3% but the volume of timber killed was estimated to have decreased by 36% to 6000 m^3. The locations of the infestations remained approximately the same as 1989 with scattered attacks noted along Lillooet Lake and Birkenhead and Gates rivers.

Mid-coast TSA

An estimated 13 infestations covering approximately 5 ha were mapped along the north side of the Dean River to the north of Bella Coola. Though relatively insignificant at this time, the population could expand and these small infestations coalesce into larger areas causing substantial damage.

Sunshine Coast TSA

For the second consecutive year no beetle attacks were noted in the Sunshine Coast TSA. As recently as 1986, an estimated 2770 ha of infested lodgepole pine were mapped along the Homathko River; until the remaining pine reaches maturity, the mountain pine beetle will probably remain at endemic levels. Beetle populations are increasing directly to the north of the headwaters of the Homathko River in the Cariboo Forest Region.

Pine needle sheathminer
Zelleria haimbachi

The pine needle sheathminer lightly defoliated young lodgepole pine over a wide area in the Vancouver Region for the fifth consecutive year. Damage which was less severe than in 1989, occurred from Texada Island in the west to the Mowhokam Creek drainage in the east to as far north as D'Arcy, and south to Harrison Lake. Young, 5- to 25-year-old, opengrowing pine were the preferred host but ponderosa pine in the northerly interior portions of the Region were also lightly defoliated.

The percentage of trees attacked ranged from 9% in young stands along the Nahatlatch Creek to 25% at Twin One Creek east of Mt. Currie. Light defoliation occurred in all areas with less than 6% of the current growth killed.

This native moth of young 2-3 needle pines is not a rare species, but it and its damage are relatively inconspicuous unless the population is large. Parasitism plays an important role in controlling populations; the most numerous *Z. haimbachi* parasites come from the wasp families Ichneumonidae, Braconidae and Chalcididae. Historically, infestations have lasted only a few years. Young stands will continue to be monitored in 1990.

European pine shoot moth
Rhyacionia buoliana

For the second consecutive year, European pine shoot moth was found in Douglas-fir buds in a plantation near Richmond. It was found there in 1989, the first time in North America. Three infested leaders were found out of 300 Douglas-fir trees examined in a mixed conifer Christmas tree plantation. The Douglas-fir trees were adjacent to Scots pine, 90% of which were severely infested by the shoot moth. The Douglas-fir would probably not have been attacked if it had not been growing in such close proximity to the infested pine, also pruning for tree form caused abnormal thickening of the terminal shoots which the shoot moth prefers, predisposing otherwise non-susceptible trees to attack.

Prior to 1988, it was thought that this shoot moth occurred only on 2- and 3-needle pines such as Scots, Austrian, Mugho, lodgepole and ponderosa; however, last year a report from Chile confirmed that European pine shoot moth was collected on Douglas-fir for the first time ever. The shoot moth is not expected to become a significant pest of Douglas-fir.

The European pine shoot moth is established in ornamental pine trees on Vancouver Island from Victoria to Courtenay, in the lower Fraser Valley from Vancouver to Chilliwack, and in the Okanagan Valley. Threat of damage to natural stands and the ever increasing pine plantations in B.C. warranted regulations to prevent the movement of infested pines to uninfested areas. These regulations lapsed in 1981. Surveys will continue in 1991.

A pine needle cast
Lophodermella concolor

This needle cast fungus infected up to 95% of the year-old and older foliage on 100% of the 10- to 20-year-old lodgepole pine trees over 50 ha in 1- to 5-ha patches along Br. 400 of the Scuzzy Creek road.

The foliage samples collected were so heavily infected with the secondary fungus *Hendersonia pinicola* that it was only possible to identify the primary fungus to the family Hypodermataceae of the class Ascomycetes, probably *L. concolor*. *H. pinicola* is believed to be a biological control agent of the hypodermataceous needle parasite.

Discoloration, death and premature casting of needles are the most common symptoms of this disease and very apparent at this particular location. No mortality was noticed or expected as a result of the infection by the disease which does not affect the health of the tree unless heavy and repeated infection occur in successive years. Extensive defoliation can affect growth and shape of trees.

A pine sawfly
Neodiprion nanulus contortae

For the second consecutive year, a pine sawfly has severely defoliated 15- to 20-year-old lodgepole pine in a 15-ha plantation at 20 km of Spuzzum Creek northwest of Yale. Small tufts of new foliage were all that remained on most trees after feeding finished in July. Severe defoliation of individual ornamental shore pine was also noted at several locations in the Mission area.

No mortality is expected this year at Spuzzum Creek but if the infestation continues next year, trees could be killed outright or weakened and then succumb to other insects. Epidemics have been reported in Oregon during the 1940s and 50s, but not previously in the Vancouver Region.

A weevil
Scythropus californicus

This broad-nosed weevil continued to lightly and severely defoliate western white pine over a wide area on Texada Island and the Sunshine Coast. Most of the young, up to 5 m in height, white pine in scattered locations throughout the area were attacked. An average 40% of the old foliage on natural and planted trees was damaged. No permanent damage is expected but minor growth loss will occur.

The weevils bite out chunks of the needle, leaving a saw-toothed edge and causing the needle to die and drop prematurely. After egg hatch, the larvae drop to the ground and feed on pine rootlets. The life cycle is believed to be 2 years.

Porcupine damage

Porcupines continued to kill 10- to 15-year-old lodgepole pine in the Mowhokam and Uztlius Creek drainages east of Boston Bar. About 5% of the pine has been killed at both locations with the same number of trees scarred. Bole scarring resulting from the porcupine feeding was most evident at the base but was also commonly noted all along the trunks of numerous trees.

This is a relatively new phenomenon in the area and is probably related to an increase in the porcupine population due to an absence of their main predator, the marten.

HEMLOCK PESTS

Western blackheaded budworm
Acleris gloverana

Defoliation by western blackheaded budworm of western hemlock near Holberg on northern Vancouver Island declined significantly to 630 ha (Map 3) from 7400 ha in 1989. The decline was general and widespread and due in part to the reduced numbers of eggs in 1989 (avg. 15/sample, down from 55 in 1988), and an egg-larval parasitoid, Ascogaster sp. There was no defoliation south of Quatsino Sound.

Aerial surveys, in cooperation with Western Forest Products Ltd., mapped light defoliation in 11 separate patches: four areas totaling 405 ha from Holberg, east to Clesklagh Creek and north of Holberg Inlet to the Goodspeed River; one of 150 ha near Pegattem Creek; and six patches totaling 75 ha in the Macjack River Valley and southeast to Moore Lake.

Top-kill of mature and immature western hemlock totalling 225 ha was mapped at nine widely scattered locations: one patch over 35 ha just north of Holberg; patches of 19 and 60 ha in the San Josef River drainage; four patches of 13, 35, 15 and 5 ha near Moore Lake; and two of 20 and 23 ha in the Ronning Creek drainage. Top-kill averaged 1 m on 22% of 206 immature western hemlock examined at two sites near Pegattem Creek south of Holberg, where stands were defoliated in 1988 and 1989. Affected trees have lost several years of height growth and could develop crooked stems or multiple tops. Assessments to further determine growth loss and recovery will be repeated in 1991. Following the 1970-73 infestation on Vancouver Island, there was little top-kill and generally good recovery of second growth trees.

Two egg samples from near Holberg containing only trace levels of eggs indicate continuing declining populations. Growth and mortality loss surveys will continue.

Commercial formulations of Bacillus thuringiensis (B.t.) were applied aerially in nine blocks, totaling about 300 ha near Holberg. This was the second consecutive year of field trials of a cooperative study with Western Forest Products Ltd., the B.C. Ministry of Forests, and Forestry Canada. Products from three different manufacturers were tested. Two water-based and one oil-based formulation were applied on each of three plots; results will be available later. Initial results of the 1989 tests found that an average of 52% of budworm larvae that fed for 6 days on the sprayed foliage were killed.

A cooperative study with Simon Fraser University and Forestry Canada to test chemicals to attract male adult blackheaded budworm was initiated at three sites near Holberg; testing will continue in 1991.

Queen Charlotte Islands

Following the collapse of the blackheaded budworm infestation in 1987, populations have remained very low. No budworm larvae were collected in standard three tree beating samples in 1990, and populations are expected to remain low in 1991.

In 1985, 10 long term study plots were established on southern Moresby Island and its archipelago to monitor the effects of successive years of defoliation by the budworm and hemlock sawfly. These were revisited in 1989 and increment cores were taken from 10 trees at each site to determine the effects of defoliation on radial growth and monitor tree recovery following the collapse of populations in 1987. Information with respect to this study is contained in a special F.I.D.S. report (see Appendix X).

Assistance in establishing the plots and conducting aerial surveys was provided by Western Forest Products Ltd., and in part by MacMillan Bloedel Ltd. Funding for the re-examination was provided by the South Moresby Forest Replacement Fund.

Hemlock sawfly
Neodiprion tsugae

The bulk of hemlock sawfly populations collapsed on the Queen Charlotte Islands in 1988 following three years of destructive feeding, often in conjunction with the blackheaded budworm. However, small pockets of residual activity remained in a number of areas on Graham Island. Small collections (10-20) of cocoons were taken from branch tips of young western hemlock in the Juskatla area at Blackwater Creek, Ferguson Bay and Collinson Lake but were associated with only trace defoliation.

Historical patterns of population behavior suggest that populations will remain at near endemic levels in 1991.

Sirococcus shoot blight
Sirococcus strobilinus

This shoot blight fungus of western hemlock continued to defoliate new tips on mostly immature trees north of Vancouver and near Mission. Infected trees were noted again in the Capilano, Seymour and Coquitlam watersheds, the U.B.C. Research and the Mission Municipal Forest where an estimated 25% of the immature (0.5- to 3-m western hemlock) were affected at all locations. Defoliated new shoots ranged from 5-30% (average 10%) in mostly overstocked stands.

On the Queen Charlotte Islands, the incidence of hemlock shoot blight was similar to 1989, with tip kill in young, primarily naturally regenerated western hemlock on both Graham and Moresby islands. Severe infections killed up to 80% of the new lateral and terminal shoots, particularly in dense natural regeneration along roadsides at 200 m elevation in the Deena Creek drainage, the lower Yakoun River and near Port Clements. In the Honna River drainage and near Rennell Sound, tip kill ranged as high as 30% and 10%, respectively, but averaged less than 5% in both areas.

Infections are promoted by cool wet weather during the period of bud flush and early shoot development.

TRUE FIR PESTS

Western balsam bark beetle-fungus complex
Dryocoetes confusus
Ceratocystis dryocoetidis

For the third consecutive year, balsam bark beetle in conjunction with the pathogenic fungus Ceratocystis dryocoetidis caused scattered light mortality over 1385 ha, up from 1165 ha in 1989, 470 ha in 1988 and 420 ha in 1987 (Table 5). The increased area of mortality is mainly due to increased aerial coverage. Tree mortality was recorded in the Fraser, Soo and Mid-Coast TSAs over 1010, 365 and 10 ha, respectively. Although the area of mortality increased this year the number of trees killed decreased slightly due to lack of aerial surveys in areas of severe mortality along Talchako and Tulameen Rivers.

Table 5. TSA, location, area, number and estimated volume of balsam trees recently killed by western balsam bark beetle-fungus complex determined from aerial surveys, Vancouver Forest Region, 1990.

TSA and Location	Area(ha)		Number of trees killed		Volume of host killed (m^3)	
	1990	1989	**1990**	1989	**1990**	1989
Fraser TSA						
Ainslie Cr.	**255**	92	**2 500**	900	**2 800**	1 000
Anderson River	**40**	60	**400**	600	**400**	650
Kookipi Cr.	**110**	100	**1 100**	1 000	**1 200**	1 100
Log Cr.	**190**	185	**1 900**	1 800	**2 100**	2 000
Maselpanik Cr.	**10**	10	**100**	100	**140**	140
Mowhokam Cr.	**215**	210	**2 100**	2 100	**2 300**	2 300
Spuzzum Cr.	**55**	40	**500**	400	**550**	30
Tulameen River	**-**	300	**-**	2 900	**-**	3 300
Nahatlatch Lake	**135**	-	**1 300**	-	**1 400**	-
Soo TSA						
Horlick Cr.	**310**	50	**3 100**	500	**3 400**	600
Birkenhead River	**35**	40	**300**	400	**350**	500
Haylmore Cr.	**10**	10	**100**	100	**100**	100
Tenquille Cr.	**10**	-	**100**	-	**100**	-
Mid-Coast TSA						
Talchako River	**-**	70	**-**	3 500	**-**	4 000
Noosquleh River	**10**	-	**100**	-	**100**	-
TOTAL	**1 385**	1 165	**13 600**	14 300	**14 940**	15 820

This beetle is a chronic pest in many subalpine fir stands in the Region. The sporadic and frequently remote occurrence and the retention of red foliage for several seasons defies a consistent and accurate assessment. Studies have indicated that the beetle rarely attacks more than 10 trees/ha in one year.

Balsam woolly adelgid
Adelges piceae

Continuing surveys in the Region detected active adelgid populations on true fir for the first time on Hornby Island, outside the quarantine zones, and within the zones at several locations including over 150 ha of balsam mortality near Port Alberni.

Seven pockets of amabilis fir mortality totalling 150 ha near Lizard Lake east of Port Alberni were mapped during aerial surveys. The mortality is bordering the Balsam Woolly Adelgid Quarantine Zone and could be adelgid related

as active populations were collected in the area early in the summer. However, the low population levels detected would not have caused mortality on their own; other factors such as root rot, poor site, over-maturity or environmental may have contributed to or been the sole cause of the mortality . The spread of balsam mortality will continue to be monitored in this area.

Along China Creek southeast of Port Alberni, near the boundary of the quarantine zone, symptoms including several dead trees and dead foliage in the upper and mid crown were noted over approximately 2 ha of amabilis fir. The adelgid was absent in samples from the area; however, this pest had previously been recorded on the opposite side of the valley.

At Saanich Seed Orchard, 35% of young amabilis fir trees were moderately infested causing gouting and deformed growth. At Mt. Newton Seed Orchard, no adelgids were found in samples, however gouting was visible on 10% of the young amabilis fir.

Scattered areas of mature amabilis and grand fir throughout Vancouver Island have shown a general decline in vigor, including some mortality, dead tops and sparse foliage. These symptoms may be a result of adelgid feeding; however, further surveys of this quarantined pest are necessary to identify the causal agents in 1991.

A balsam shoot boring sawfly
Pleroneura sp.

For the third consecutive year, sawfly populations continued to kill high numbers of new shoots of amabilis fir in higher elevation forest stands near Sechelt, Chilliwack and North Vancouver.

In high-elevation stands (1 000 m) east of the Sunshine Coast, in the Vancouver watersheds, on the north end of Vancouver Island and along the Chilliwack River Valley, bud mortality ranged from 5-30%, average 10%, on up to 70% of the young 2-5-m trees. Older trees are also affected but examination of the upper crowns of mature balsam is difficult or not warranted as the sawfly does not seem to be a very destructive pest in the short time it has been evident in British Columbia.

Mining by the sawfly causes shoot deformity and usually kills the shoot. Infested shoots turn a reddish brown, resembling frost damage, and the dead parts of the shoots will eventually fall off. No studies have been done on the extent of the resultant growth loss from the absence of lateral shoots but it would probably be minor. There is one sawfly generation a year with adults emerging in the spring from overwintering pupae or cocoons. Eggs laid near the tip of the shoot hatch into creamy-white grubs which burrow into the shoot axes and feed until mid-summer, then drop to the ground to spin cocoons.

The sawfly has not previously been considered a noteworthy pest of true firs in British Columbia. In 1988, it was recorded near Holberg on Vancouver Island for the first time.

SPRUCE PESTS

Spruce beetle
Dendroctonus rufipennis

Spruce beetle populations declined for the fourth consecutive year to endemic levels throughout the Region. The only recently recorded infestation was 5 ha of mature Sitka spruce in the upper Nusatsum River area near Bella Coola which was logged in the spring of this year. Elsewhere in the Region, due to host depletion and logging activity the spruce beetle is no longer evident at Manning Park, Upper Tulameen River, Hubbard Creek, and Holding Creek drainages. Surveys for this pest will continue in 1991.

Spruce weevil
Pissodes strobi

The spruce weevil continues to cause leader mortality of immature Sitka spruce throughout the host's range in the Region.

Surveys in 1990 recorded an average of 27%, range 1-50%, of the leaders attacked at nine locations on Vancouver Island from Jordan River to Holberg, compared to 43% at eight different locations on Vancouver Island and the mainland in 1989. Weevil attacks have been a chronic problem in the Vancouver Region for several decades, with populations fluctuating from year to year and site to site but always evident and showing an increase over the long term. Clipping and predator release programs have been ongoing for several years with varying degrees of success. There is potential for a reduction of merchantable timber at rotation age due to crook, stem decay and other deformities resulting from weevil attack. Surveys and clipping programs will continue in 1991. Studies to reduce weevil populations are currently underway by research staff at PFC.

Spruce aphid
Elatobium abietinum

Defoliation of spruce trees by the spruce aphid increased dramatically, causing extensive defoliation and some mortality of natural and ornamental spruce, mostly in coastal and some urban areas. Defoliation of ornamental and native spruce occurred at scattered sites from Port Hardy to Hope with up to 100% of the foliage killed and probably some trees. Tree mortality will be more easily identified at flush next spring. Populations remained low on the Queen Charlotte Islands for the second consecutive year.

It is expected that the intensity of defoliation in 1990 will again be linked directly to fluctuations in climatic factors, particularly the length and severity of winter cold spells. Forestry Canada will continue to monitor this pest in 1991.

Spruce bud necrosis

Terminal bud necrosis, first reported following the cold winter of 1988-89, was repeated in 1990 due to a period of extreme cold weather accompanied by high winds in February. Most severely affected were plantation

Sitka spruce situated on sidehills and ridges above 150 m in the Heather Lake area and in the Deena drainage on Moresby Island, where more than 50% of the trees bore multiple tops. Lesser damage was seen on Graham Island in exposed plantations in the Honna River drainage and near Juskatla. Spruce was the only species affected.

When terminal buds are lost, two or more lateral shoots at the apex compete for apical dominance. If one shoot is successful and over-tops the others within the first few years, normal growth is resumed with little or no long-term effect. However, if no single shoot achieves dominance and multiple tops persist, it may become necessary to survey the most severely affected stands and subsequently mount a clipping program to thin the multiples.

Samples examined at the Pacific Forestry Centre have failed to yield any insect or disease associated with the bud necrosis. The same phenomenon affects Sitka and Interior spruces in the Prince Rupert and Prince George Forest Regions.

Cooley spruce gall adelgid
Adelges cooleyi

This insect was collected for the first time on the Queen Charlotte Islands this year, when more than 80% of the needles were infested on six ornamental Douglas-fir near Queen Charlotte City. The trees, which are not indigenous to the Islands, had been introduced as seedlings around 1970 from Yale in the Fraser Canyon. A survey of nearby Sitka spruce, the alternate host of the insect, found none of the characteristic branch galling that can result in significant loss of growth potential in young trees. The insect can survive in either host species independent of the other but, in instances where the adelgid cycles on a single host, reproduction is parthenogenic, and the life cycle abbreviated. The damaging cone galls on Sitka spruce are formed only when Douglas-fir is present.

An assessment of known ornamental and industrial Douglas fir plantations in the Islands is currently being conducted by the Forest Service and forest companies. The infested trees near Queen Charlotte City will be treated with insecticidal soap.

Spruce needle cast
Lirula macrospora

This needle cast infected sapling-sized planted and natural Sitka spruce at widespread locations on the Queen Charlotte Islands. The most severe infections were in the Heather Lake area on Moresby Island, where up to 80% of the year-old needles were killed on about 20% of the trees scattered throughout the stands. Similar infections were seen in the Skidegate Lake area and in the Marie Lake and Yakoun Lake areas farther north, but less than 10% of the trees were infected.

It is a characteristic of this disease that killed needles are retained by the trees often for more than a year. This facilitates the transfer of spores by rain splash from old to tender new needles early in the next growing season. The severity of infections in 1991, therefore, will depend largely on moisture conditions at the time of budbreak.

CEDAR PESTS

Yellow cedar mortality

The phenomenon of yellow cedar dieback on the Queen Charlotte Islands has been studied for many years but as yet no causal organisms have been isolated. Compounding this problem is the more recent unexplained whole-tree mortality of yellow cedar. During aerial surveys over the past decade, scattered individuals and small patches of dead yellow cedar were seen on primarily eastern slopes of Moresby and Louise islands and on western Graham Island. Only trees over 40 years old appear to be affected. Samples of discolored foliage from dying trees in the mountain pass on the road to Rennell Sound were examined at PFC; however, no pathogens or insect pests were identified. Environmental and poor site factors were cited as likely causes of the mortality. Further, more detailed studies are planned for the future.

Cedar leaf blight
Didymascella thujina

Infections by this leaf blight causing widespread foliage discoloration of western red cedar throughout the Region have increased this year. This disease is very common in forest stands on the the north shore of Vancouver and the Upper Fraser Valley, and in the Marie Lake area on Graham Island in the Queen Charlottes. Up to 100% of the old foliage is affected on groups or scattered individuals in the denser cedar stands but infections are more common on the lower branches.

The infected leaves may be mistaken for natural flagging which commonly occurs on western red cedar; in both cases foliage turns reddish over the summer. In the case of the leaf blight, the older branches will become gray and small black fruiting body holes can be found on the upper side of infected leaves. Continued high levels of infection next year could cause mortality to saplings while older trees will exhibit growth reduction and dead branches.

Cedar flagging

Highly visible flagging of western red cedar foliage is evident throughout the Pemberton Valley and along the Birkenhead and Green rivers. This common phenomenon is more apparent this year than in any year over the past decade.

The affected cedar trees are in the Interior Douglas-fir and Drier Submaritime Coastal Western Hemlock biogeoclimatic zones and are somewhat off site. Discolored trees, with up to 100% foliage affected, are growing in close proximity and sometimes next to dead and dying trees or trees with dead tops. Cedar flagging is usually not considered to be detrimental to tree growth but with the dry summer and slightly off-site conditions, the possibility of increased mortality and top-kill exists. Root rot could be the cause of the cedar deterioration in the area, however, extensive surveys would be needed to confirm this.

SPECIAL SURVEYS

Pinewood Nematode
Bursaphelenchus xylophilus

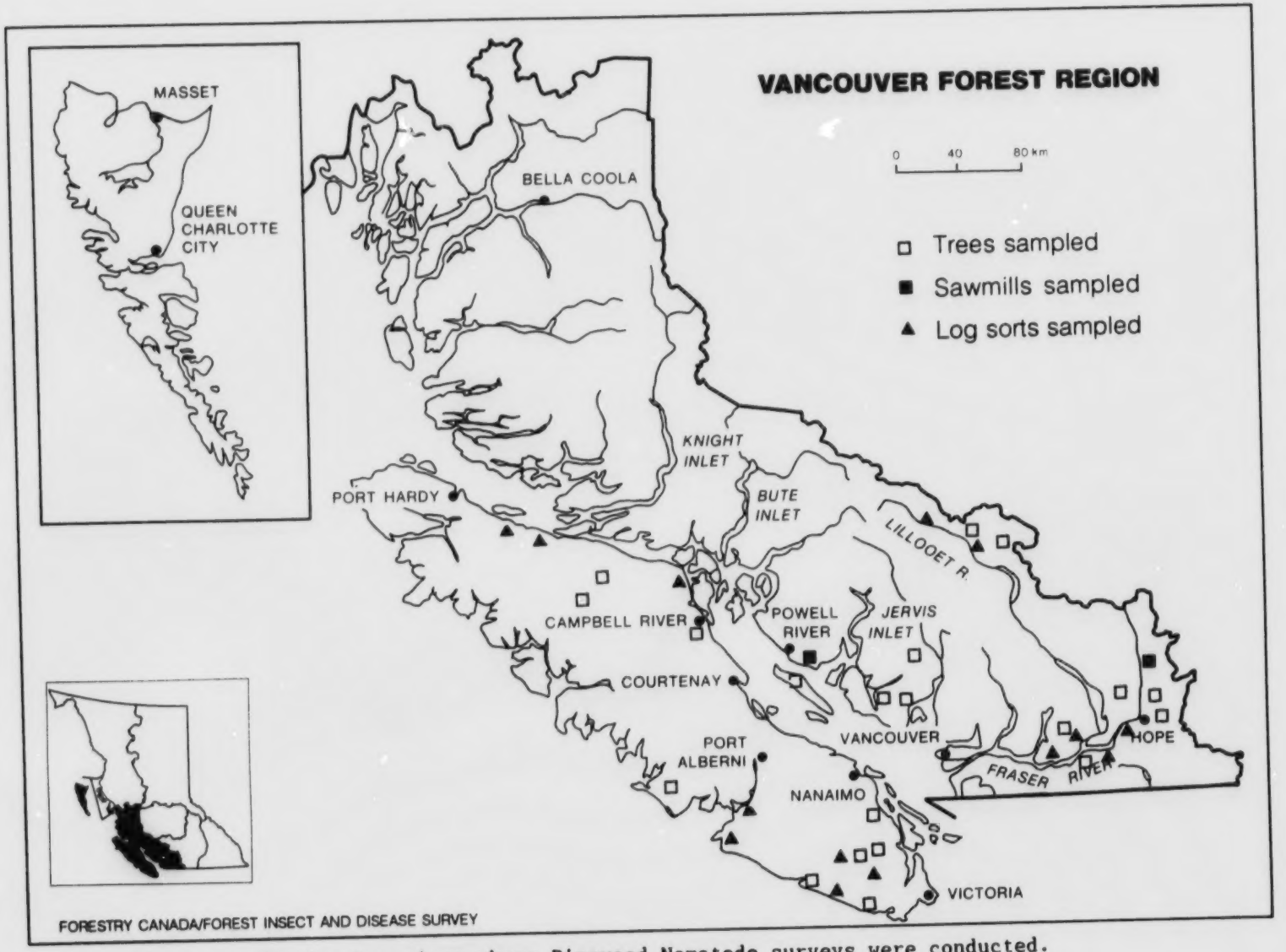
Host Exemption Surveys

Between January and August 1990, more than 1300 cedar, hemlock and balsam logs from 16 storage yards, 61 live trees from 11 sites, and 11 samples of manufactured wood from 2 locations were examined for evidence of insects which could potentially vector pinewood nematode (Map 4). None contained pinewood nematode. This was in response to, and with considerable cooperation from, the Council of Forest Industries, to obtain information to further support the request for exemption under the pinewood nematode lumber ban of species such as cedar and hemlock. Balsam was also sampled even though **Monochamus** wood borers, considered to be the main insect vector of the pinewood nematode, have previously been collected from **Abies spp.**

Sixteen log-sorting yards, operated by seven different companies logging Vancouver Island, mid-coast areas, Fraser Canyon, Lillooet River and the lower mainland were inspected. Most of the logs had been cut 3 to 6 months previously; however, all yards had at least a few logs cut up to 2 years ago and these frequently had the most evidence of insect attack. Large patches of bark ranging from 30 cm to 200 cm were stripped at intervals along each log. Of the 1329 logs inspected 575 were western hemlock, 471 western red cedar, 114 yellow cedar and 169 amabilis fir (Table 6).

Insect activity was detected in 319 (24%) of the logs and representative samples returned to the Insectary for identification. Samples of the insect-affected portion of 125 logs and 61 unaffected (unblemished logs) were cut at the laboratory into 2 x 20 cm chips and incubated for a week at room temperature; then, any nematodes were extracted by covering with water overnight, screening and concentrating using a Baermann funnel, followed by examination in a watchglass. Extraction and identification were by F. Ring and Dr. J. Sutherland.

No **Monochamus** wood boring species were detected in the cedar or amabilis fir logs and only 1 adult **M. scutellatus** and a larva were detected in a single hemlock log. In the 24% of the logs which did have indications of insect activity, about three-quarters had only damage and old feeding evident, while larvae and occasionally adults were obtained from about one-quarter of the samples during detailed dissection and inspection in the laboratory. Insects which were identified but which are not known associates of the pinewood nematode were in decreasing order of occurrence (Table 7) in western hemlock: a bark beetle, **Pseudohylesinus tsugae**; a wood borer, **Melanophlia drummondi**; ambrosia beetles, **Trypodendron lineatum**; and a cerambycid wood borer, probably **Xylotrechus longitarsis**. From cedar, the insects detected were: a wood borer, **Semanotus ligneus**; bark beetles, **Phloeosinus punctatus**; false powder post beetles, **Anobiidae**; a cerambycid, probably **Ergates**; and a weevil, **Rhyncolus brunneus**. Insects found in amabilis fir: a horntail, **Siricidae**; a wood borer, **Melanophlia drummondi**; and a cerambycid wood borer. These insects were present in small numbers at most log yards; however, they were predominately found in the bark or cambium level and would be removed during processing or easily detected during the mill certification program.



Map 4. Locations where Pinewood Nematode surveys were conducted.

Table 6. Dryland sorting yards inspected for insect and nematode activity in hemlock and cedar logs.

Location/Company	Tree species[1]	Logs inspected (number)	Insect damaged logs		Logs sampled for nematodes		Source of logs
			No.	Percent	Insect infested	Unblemished	
Caycuse Fletcher Challenge	wrC wH	60 60	30 31	50 52			Nitinat Lake and River drainage
Bear Lake Interfor	wrC wH yC	20 20 20	4 2 4	20 10 20	3 2 4	2 2 1	Salmon River-Sayward area
Beaver Cove Canfor	wrC wH yC aF	35 32 1 5	5 5	14 16	5 5	 2	Nimpkish River
China Creek Macmillan Bloedel	wrC wH aF	35 35 15	9 4 6	26 11 40	5 4 5		Franklin River
Sarita MacMillan Bloedel	wrC wH aF	30 30 10	9 6	30 20	5 5		Darling and Sarita rivers
Eve River MacMillan Bloedel	wrC wH yC aF	40 30 10 10	6 4	15 13	6 4		Eve and Tsitika rivers
Hope Interfor	wrC wH yC aF	37 35 33 10	5 8 2 3	14 23 6 30	5 5 3 3	2 2 2	Upper Fraser River

Location/Company	Tree species[1]	Logs inspected (number)	Insect damaged logs		Logs sampled for nematodes		Source of logs
			No.	Percent	Insect infested	Unblemished	
Whonnock	wrC	40	1	3	1	2	North Shore Fraser River
Interfor	wH	38	3	8	3	2	
	yC	13	2	15	2	2	
	aF	14	1	7	1	2	
Gibsons	wrC	38	9	24	5	2	Rivers and Toba inlets
Weldwood	wH	46	19	41	5	2	
	yC	12	1	8	1	1	
	aF	15	4	27	4	2	
Squamish	wrC	71	10	14	7	4	Mamquam River
Weldwood	wH	69	11	16	5	4	
	aF	40	9	23	5	4	
Pemberton	wrC	25	25	100	2	0	Soo TSA
Weldwood-Canfor	wH	20	12	60	2	2	
	aF	20	12	60	2	2	
Hurley Pass	wrC	20	8	40	2	2	Lillooet River
Interfor	wH	20	14	70	2	2	
Chilliwack	wrC	20	6	30	2	2	Fraser TSA
Cattermole Timber	wH	20	1	5	1	2	
	aF	10	0	0	0	2	
Harrison Mills	wH	20	13	65	2	2	Dewdney and Harrison Lake
Canfor	aF	20	15	75	2	2	
Honeymoon Bay	wH	50	0	0	0	2	south of Covichan Lake
Fletcher Challenge	yC	25	0	0	0	1	

Location/Company	Tree species[1]	Logs inspected (number)	Insect damaged logs		Logs sampled for nematodes		Source of logs
			No.	Percent	Insect infested	Unblemished	
Jordan River Western Forest Products	wH	50	0	0	0	0	north of Jordan River
TOTALS	**wrC**	471	127	27	49	16	
	wH	575	133	23	45	22	
	yC	114	9		9	5	
	aF	**169**	**50**	**29**	**22**	**18**	
TOTALS		**1329**	**319**	**24**	**125**	**61**	

[1] wrC - western red cedar, Thuja plicata
wH - western hemlock, Tsuga heterophylla
yC - yellow cypress, Chamaecyparis nootkatensis
aF - amabilis fir, Abies amabilis

Table 7. Bark and wood boring insects detected in western hemlock, western red cedar and amabilis fir logs in dryland sorting yards in coastal British Columbia, 1990.

Location	Log species	Insects Detected[1]									
		Mel.	P.t.	S.l.	Ph.p.	T.l.	R.b.	Cer.	Bup.	An.	Sir.
Caycuse	wrC			X	X						
	wH	X	X					X			
Sarita	wrC			X	X			X		X	
	wH	X	X			X		X			
	aF										
China Creek	wrC				X					X	
	wH	X	X			X		X			
	aF	X						X			X
Eve River	wrC			X	X						
	wH	X	X								
	aF										
Beaver Cove	wrC						X	X		X	
	wH	X				X		X			
	aF										
Bear Lake	wrC			X	X						
	wH	X	X								

Location	Log species	Insects Detected[1]									
		Mel.	P.t.	S.l.	Ph.p.	T.l.	R.b.	Cer.	Bup.	An.	Sir.
Hope	vrC			X	X			X	X		
	wH	X	X					X			
	aF	X						X	X		
Whonnock	vrC			X					X		
	wH	X	X					X			
	aF										
Gibsons	vrC			X	X					X	
	wH	X	X						X		
	aF										X
Squamish	vrC			X	X						
	wH	X	X					X			
	aF	X						X			
Pemberton	vrC							X			
	wH							X			
	aF	X						X			
Hurley Pass	vrC			X				X			
	wH							X			

Location	Log species	Insects Detected[1]									
		Mel.	P.t.	S.l.	Ph.p.	T.l.	R.b.	Cer.	Bup.	An.	Sir.
Chillivack	wrC				X			X			
	wH								X		
Harrison Mills	wrC							X			
	wH							X			
Honeymoon Bay	wH	-	-	-	-	-	-	-	-	-	-
Jordan River	wH	-	-	-	-	-	-	-	-	-	-

[1] An. - Anobiidae - powder post beetles
Bup. - Buprestidae - metallic wood borers
Cer. - Cerambycidae - longhorned beetles
Mel. - Melanophila pr. drummondi - flatheaded fir borer
P.t. - Pseudohylesinus tsugae - A bark beetle
Ph.p. - Phloeosinus punctatus - cedar bark beetle
R.b. - Rhyncolus brunneus - a weevil
S.l. - Semanotus ligneus - cedar tree borer
T.l. - Trypodendron lineatum - striped ambrosia beetle
Sir. - Siricidae - horntails

The live trees sampled were divided into two groups, symptomatic and non-symptomatic. Symptomatic trees are dead dying or unhealthy trees in which the casual agent is not apparent, i.e., insects, disease or environmental problems. Of the 61 living trees sampled, 9, 12, and 10 were symptomatic trees, 12, 13 and 5 were non-symptomatic from cedar, hemlock and balsam, respectively. Non-symptomatic trees were healthy trees of the same species, stand and approximate age as the symptomatic trees. Symptomatic trees usually represented a very small percentage of the whole stand, ranging from .001% to 2% of the stand. The highest number, 2%, was obtained in a very small stand of less than 250 trees. The general areas where samples were collected included Tofino, Texada Island, Sechelt, Gibsons, D'Arcy, Brackendale, Dewdney, Cultus Lake, Hope and Boston Bar.

Pinewood nematode samples were also collected from manufactured wood, with 8 cerambycid wood borer infested samples, one identified as **Monochamus** sp., from western hemlock at a sawmill at Boston Bar and 3 samples of **cerambycid** infested western red cedar samples collected near Powell River. All manufactured wood samples were partially covered with bark; waney lumber is more likely to contain nematodes.

From the 258 logs, trees and manufactured wood samples examined for nematodes, none contained pinewood nematode; however, the sampling method was effective, for about half the samples of each tree species contained other non-plant parasitic genera of nematodes, which are commonly associated with fungi or insects.

The above surveys and results did not detect pinewood nematode in cedar, hemlock or balsam, and only two sample of its potential vector, **Monochamus** spp. were detected in hemlock. This, along with previously reported negative results in seedling susceptibility trials and the historical records of insects found in these tree species, further supports the request for exemption of cedar and hemlock from the pinewood lumber ban.

Seed orchards

Eleven seed orchards in the Vancouver Region were surveyed two or more times during 1990 for early detection of insects, diseases and abiotic damage as well as damage assessments, discussions of management options and transfer of technical information. In previous years, pests of cones in the seed orchards received the most attention; however, this year surveys have shifted to the pests damaging the trees while the BCFS has concentrated on the examination of cones. During these surveys, numerous insects, diseases and other problems were recorded some of which are:

The **Cooley spruce gall adelgid**, Adelges cooleyi, was the most common pest on Douglas-fir, lightly to severely infesting 100% of the trees at five of nine orchards. Low levels, but potentially damaging, of **western spruce budworm**, Choristoneura occidentalis, were recorded at five orchards.

Sirococcus shoot blight, Sirococcus strobilinus, was the most damaging pest of western hemlock causing branch tip dieback on 10% of the trees at one of six locations surveyed.

Damage by the **balsam woolly adelgid**, Adelges piceae, was noted at the four seed orchards growing Abies spp. The **balsam twig aphid**, Mindarus abietinus, deformed needles and twigs on approximately 15% of the trees at two orchards.

Moderate defoliation of spruce trees by the **green spruce aphid**, Elatobium abietinum, was noted on 5-70% of the trees at three of four orchards that grow spruce. Galls formed by the **Cooley spruce gall adelgid**, Adelges cooleyi, were noted on an average of 5% of the trees at two seed orchards.

A complete detailed list of all pests has been compiled as an appendix to this report and is available upon request. Surveys will continue in 1991 and significant problems will be reported as noted at that time.

Acid rain plots

In addition to the annual assessments which include tree condition and mortality, acid rain symptoms and insect and disease conditions, the five year assessment was also completed at the 10 ARNEWS (Acid Rain National Early Warning System) study plots. Every five years, the ten plots are surveyed for radial and vertical growth, crown structure and density and the chemical analyses of foliage and soil. These measures are meant to detect any early signs of damage to trees and soils caused by low pH rainfall and to identify damage not attributable to natural causes. No **acid rain** symptoms, including damage to vegetation that cannot be diagnosed as biotic or abiotic, were observed in 1990. **Tree mortality** (Table 8) has occurred in 9 of the 10 plots but all deaths can be attributed to natural causes, competition and shading out. The highest incidence of tree mortality was at UBC Research Forest where 19 (30%) of the plot trees, mostly understory western hemlock, have died since 1984. Very few significant insect or disease symptoms were noted this year except for **Phellinus root disease** which infected an estimated 10% of the Douglas-fir at the Salt Spring Island plot. **Armillaria root disease** was suspected to be killing amabilis fir off-plot trees at the Coquitlam West site.

Table 8. Tree mortality recorded in ARNEWS plots from 1984-1990 in the Vancouver Region, 1990.

Plot and plot number	Year established	Number of trees: Original plot	Number of trees: Died since plot establishment	Tree species	Remarks
U.B.C. Forest - 902	1984	50	12	wH	Shaded out
		14	6	vrC	Shaded out
		1	1	wB	Shaded out
Shavnigan Lake. - 901	1984	130	20	D-fir	Shaded out
Salt Spring Island - 903	1984	102	13	D-fir	Shaded out
			1	D-fir	Phellinus weirii
Jones Lake - 909	1985	60	2	wH	Shaded out
			1	wH	Blowdown
		3	1	D-fir	Unknown
John Hart Lake - 904	1985	31	1	D-fir	Unknown
Seymour River - 911	1986	38	2	D-fir	Unknown
Seymour River - 912	1986	52	2	D-fir	Snov damage
Capilano River - 910	1986	75	2	aF	Pseudohylesinus sp.(Bark beetle)
Coquitlam River - 914	1986	65	0	-	-
Coquitlam River - 913	1986	71	1	vrC	Shaded out
TOTAL		**692**	**65**		

These plots are part of a national system to gather baseline data on acid rain in Canada's forests. The data are needed to clearly and accurately detect early signs of acid rain damage and to annually monitor for changes in forest conditions.

Fume damage

Foliage discoloration in scattered patches and previously noted cumulative damage, i.e., dead snags over 300 ha, were visible near the Port Alice pulp mill in 1989. Previous surveys indicated 60% of the western hemlock were affected. This area will continue to be monitored by FIDS in the ensuing years.

Several fume damage assessment plots were established in the Port Alice area by the BCFS in conjunction with the Ministry of Environment. During 1988

foliage samples of western hemlock and Douglas-fir were collected to be analyzed for terpene composition and sulphur content. While all the analyses are not yet completed, some preliminary results for western hemlock indicate that samples at a remote site (Alice Lake) have a higher sulphur content (either organic or inorganic) than samples collected at close proximity to Port Alice. In both Douglas-fir and western hemlock, total sulphur content increases with the increasing age of the foliage.

MULTIPLE HOST PESTS

Pests of young stands

More than 2700 trees in 30 young, 2- to 25-year-old planted and natural stands, were examined in the Region in 1990. This was part of a continuing study to identify and quantify pest and environmentally related problems and their impact on young stands. At least seven trees were examined at each of 10 or more circular plots at each location. Douglas-fir were the major component in about 45% of the sites, amabilis fir in 18%, western hemlock in 17%, cedar in 13%, Sitka spruce in 12%, white pine in 5%, and Engelmann spruce and lodgepole pine in 4%. About 60% of the trees were pest free. Pests, diseases or other problems found during the surveys are listed in Table 9.

Table 9. Summary of pests in young stands in the Vancouver Forest Region, 1990.

Host species	No. of stands[1]	No. of trees	Pest or problem	Number of sites with pest	Trees affected		Damage Index	
					Avg. Percent	Range	Avg.	Range
Douglas-fir	18	1055	Cooley spruce gall adelgid	12	55	3-100	2	-
			chlorosis	2	51	2-100	2	-
			mortality	3	12	6-24	6	-
			deer browse	3	17	5-39	2	2-3
			grouse damage	1	42	-	2	2-3
			winter damage	4	26	2-57	2	-
			D-fir needle cast	1	6	-	2	-
			western spruce budworm	1	8	-	2	-
			fir coneworm	1	10	-	2	-
			herbicide damage	1	13	-	2	-
			PEST FREE	10	76	43-100	-	1
Amabilis fir	7	347	Winter damage	4	31	9-89	2	-
			chlorosis	3	21	4-46	2	-
			grouse damage	1	31	-	2	-
			balsam twig aphid	1	42	-	2	-
			PEST FREE	7	60	11-100	2	1
Western hemlock	7	337	PEST FREE	7	100	-	-	1

Host species	No. of stands[1]	No. of trees	Pest or problem	pest	Trees affected Avg. Percent	Trees affected Range	Damage Index Avg.	Damage Index Range
Western red cedar	5	230	Cedar leaf blight	2	65	30-100	2	-
			PEST FREE	4	93	70-100	-	1
Sitka spruce	3	230	Cooley spruce gall adelgid	3	75	24-100	2	-
			Spruce weevil-new	2	12	2-22	3	-
			Spruce weevil-old	3	17	9-21	2	-
			PEST FREE	1	26	-	-	1
Western white pine	2	78	PEST FREE	2	100	-	-	1
Engelmann spruce	1	58	Winter damage	1	62	-	2	-
			bark aphid	1	14	-	2	-
			PEST FREE	1	36	-	-	1
Lodgepole pine	1	49	Pine needle cast	1	82	-	3	-
			PEST FREE	1	18	-	-	1

[1]Number of surveyed stands in which tree species comprised more than 20% of the stand.

[2]Damage index:
1. pest-free
2. damage negligible or very short term
3. loss of current growth potential
4. some net loss of volume and/or significant long term loss of growth potential
5. life threatening
6. recently dead

Frost/ice caused the most damage in young Douglas-fir stands, killing buds on an average of 26% of the trees at 4 of 18 stands. Deer browse continued to be a major concern where terminal or lateral bud damage was observed on 17% of the trees in 3 of 18 stands. The Cooley spruce gall adelgid, Adelges cooleyi, was the most common pest, infesting 66% of the stands but causing little significant damage. About 76% of the trees were pest free.

Environmental damage was also the most damaging agent in the amabilis fir stands, killing buds on 31% of trees at 4 of 7 sites. Chlorotic trees, probably caused by poor site or micro-nutrient deficiency, were noted at 43% of the sites, affecting an average 21% of the trees. Pest free trees accounted for 60% of all amabilis fir examined.

All western hemlock stands examined were pest free.

White pine weevil, Pissodes strobi, was the most damaging pest of Sitka spruce, killing from 9 to 21% of the leaders at all 3 sites surveyed. Cooley spruce gall adelgid caused light galling on 75% of the Sitka spruce examined at all sites. Pest free trees accounted for 26% of the trees examined.

The foliar disease Didymascella thujina infected 100% of the western red cedar at one site and 30% at another, but caused only minor damage. An average 93% of the trees were pest free at four of five sites.

All western white pine stands were pest free.

Frost/ice damaged new shoots on 62% of the trees at the only Engelmann spruce site where 14% of the trees were also infested by Pineus similis. About 36% of the trees were pest free.

Hendersonia pinicola, a hyperparasite, severely infected 82% of the lodgepole pine at one site; the remaining trees were pest free.

Vole damage

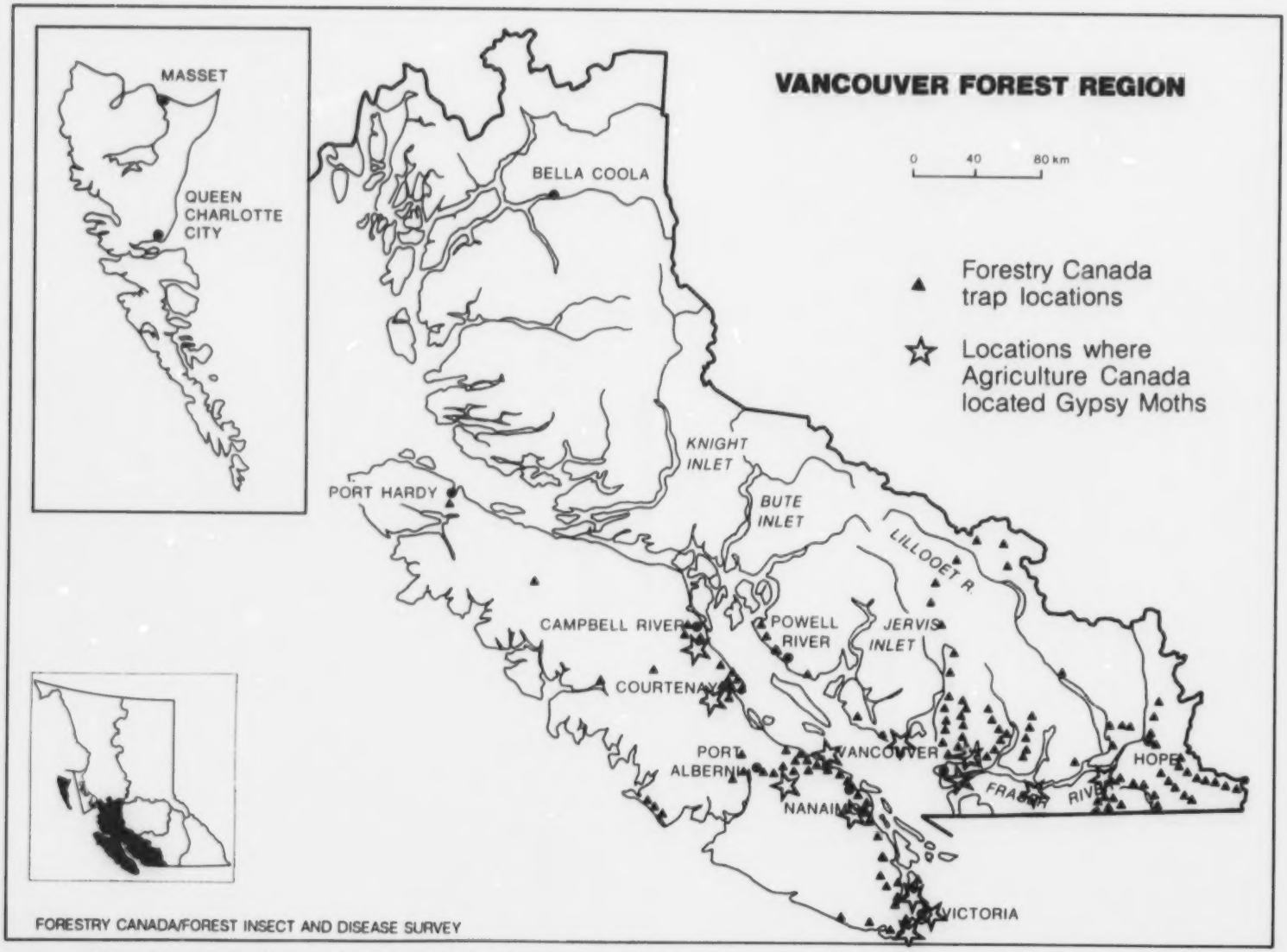
For the second consecutive year, voles are a major problem in young plantations in the Soo TSA, damaging most of the recently planted seedlings at several locations around Pemberton and Lillooet Lake.

At Tenquille Creek, approximately 90 per cent of the newly planted Douglas-fir seedlings over about 20 hectares were killed by vole feeding. All of the 3-4 year old Douglas-fir trees at a plantation near Pemberton Airport were killed by meadow voles girdling the trees at the base. Approximately 45% of the western red cedar seedlings were damaged and 10% of the stems clipped at two locations along the west side of Lillooet Lake just north of Kakila Creek.

Meadow voles are very prolific, producing five or more litters a year, averaging five young per litter. Cyclical in nature, vole numbers peak approximately every 4 years. Under favorable conditions, their numbers can reach over a thousand per hectare. Planting jumbo stock can help to limit damage as can covering seedling with a fine enough deer guard mesh that prevents voles from reaching the stems.

Gypsy moth
Lymantria dispar

Gypsy moth pheromone-baited sticky traps to attract male moths were placed at 150 locations in mainly provincial and municipal parks throughout the Vancouver Region by the Forest Insect and Disease Survey, no gypsy moths were collected in FIDS traps. A total of 120 males, 12 females, 14 pupal cases and 36 egg masses were collected in the Region by Agriculture Canada (Map 5). The majority of these were found at a site near Saanichton on Vancouver Island. All the female, pupal case and egg mass finds were made on 16 large residential properties within a 19 hectare area centering around the NW corner of Cresswell and McTavish roads. Eight scattered single male moths were caught at other areas on Vancouver Island (Table 10). On the lower mainland including the Sunshine Coast, 12 males have been caught; the largest number was 4 at North Vancouver.



Map 5. Locations of Gypsy Moth pheromone traps and sites where Gypsy Moths were caught.

This is the third consecutive year that moths have been caught at Parksville and West Vancouver. To date, populations have not become established in British Columbia and defoliation has not been observed. The major concern of the forestry sector continues to be quarantine restrictions such as those in force during 1985 in parts of Oregon.

Table 10. Locations where adult male gypsy moths were trapped in sticky traps baited with sex pheromones in the Vancouver Region, 1990.

Location	No. moths	No. traps
CFB-Esquimalt	2	2
Comox	1	1
Lantzville	1	1
Parksville	2	1
Saanichton	96	?
Cameron L.	1	1
Nanoose Bay	1	1
Campbell River	2	2
Royal Roads College	1	1
Victoria	2	2
West Vancouver	3	3
North Vancouver	2	2
Vancouver	2	2
Robert Cr.	1	1
Coquitlam	1	1
Rosedale	2	2
Total	**120**	**23(+ unknown no. at Saanich)**

Approximately 8000 sticky traps were monitored throughout British Columbia in the fourteenth year of a cooperative program with Agriculture Canada (Plant Health), B.C. Ministry of Forests, and FIDS, Forestry Canada. A total of 121 moths were caught across British Columbia this year compared with 25 moths in 1989, 12 in 1988 and 216 in 1987. Aerial and ground applications of Bacillus thuringiensis were completed by Agriculture Canada over two areas of 85 ha and 7.5 ha at Parksville, where subsequent trapping captured only 2 males outside the spray block.

Winter Damage

Winter winds in 1989 caused an estimated 9300 ha of defoliation and scattered blowdown from Hagensborg west to Restoration Bay on Burke Channel, in the Mid-coast District. Mainly western hemlock, western red cedar and amabilis fir of all age classes were affected. The damage was a result of the weather changing from unseasonably warm and wet to extremely cold and windy at the end of January and beginning of February 1989.

To assess the damage, six mature dominant hemlock were felled at Clayton Falls Creek. On the severely defoliated tress, 80% of the buds were killed as well as many of the smaller branches. Bud and branch mortality decreased as defoliation diminished. A variable prism plot cruise at the location showed 57% of the stems/ha (330 m^3/ha) probably dead, 20% (118 m^3/ha) fading and 22% (140 m^3/ha) healthy. The sapwood of each tree was examined by stripping sections of the bark and recording the moisture content. Trees recorded as "probably dead" had dry sapwood; the fading trees were moderately dry and the healthy trees were moist. Heavy mortality, more than 75%, was expected over much of the 1000 ha of severe defoliation at Clayton Falls. However, during 1990, 20% of the trees that were expected to die, refoliated. There were no secondary insects observed in large-enough numbers to be an additional hazard; however, secondary fungi will infect the damaged but surviving trees to cause stain and heart rot.

Fletcher Challenge is in the process of logging parts of this geographically difficult area and will attempt to salvage-log any mortality resulting from the severe winter of last year.

Conifer seedling weevil
Steremnius carinatus

Feeding by adult conifer seedling weevils killed 20% of newly planted Sitka spruce seedlings and partially girdled 80% of the remainder over 5 ha near Collinson Lake on Graham Island. The planted area was part of a much larger block that had been logged in 1986 and had regenerated naturally to western hemlock. A 1989 survey found the 5 ha to be NSR and the spruce were fill-planted in late March 1990. Evidence of older, non-lethal feeding damage on almost all surviving western hemlock within the planted area suggested that Steremnius was also responsible for the earlier death of most of the hemlock seedlings.

Continued weevil feeding on the spruce in the fall of 1990 may result in increased losses beyond the initially reported 20%.

Conifer seedling weevils have often caused seedling mortality on Vancouver Island and the Queen Charlottes in the past. Sitka spruce and Douglas-fir are the preferred hosts, but western hemlock and true firs are also attacked. Seedlings are susceptible to girdling at the root collar in the first two years, after which increased stem diameter precludes further mortality.

The affected area will be revisited in 1991 to assess any increases in damage.

DECIDUOUS TREE PESTS

Western winter moth
Erannis tiliaria vancouverensis

Western winter moth populations collapsed, as predicted, in most areas of the coastal mainland after 2 years of epidemic numbers. Patches of severe defoliation on broadleaf maple were still noted in the Vancouver Mainland District and over a wider area, but overall defoliation was less.

Feeding was noted from Chilliwack to Boston Bar, in the Horseshoe Bay-Squamish area and near the University of British Columbia, consisting mostly of 1-5 ha patches. At Sasquatch Park, where defoliation occurred over 500 ha in 1989, only 5 areas of 1-2 ha were recorded this year. In early May, it looked as if another year of severe defoliation could be expected in the Cultus and Harrison lakes areas as high larval numbers and feeding on the new foliage was apparent. However, by the beginning of June, a nuclear polyhedrosis virus (NPV) had infected the populations at most locations where defoliation was noted in 1989, and dead and dying larvae were commonly seen on the ground and hanging from trees. A mass collection of 3-4 instar larvae from the Cultus Lake area all died in the laboratory as a result of infection by the virus. This is common in defoliator populations and has been responsible in the past for controlling outbreaks of insects.

Growth loss will be the main impact to trees severely defoliated for 2 to 3 consecutive years. Trees usually refoliate by mid-July. Only trees already under severe stress are likely to die.

Winter moth
Operophtera brumata
Bruce spanworm
Operophtera bruceata

For the second consecutive year, increased populations of winter moth and the Bruce spanworm defoliated broadleaf maple, birch, elm, Garry oak and other ornamental and fruit trees in Vancouver Region.

On the lower mainland, damage was noted throughout Greater Vancouver and in the upper Fraser Valley, expanding from isolated patches in Richmond and Ladner in 1989. The most severe damage was noted in birch stands along Highway 99 in Richmond. This is only the second year of reported defoliation by winter moth in natural stands on the mainland.

The winter moth increased on southern Vancouver Island for the first time in six years. Deciduous hosts were lightly to severely defoliated in small, several-hectare patches throughout the greater Victoria area. Defoliation of Garry oak was heaviest in the Oak Bay area and complete defoliation of understory broadleaf maple was observed at Deep Cove and Island View Beach on the Saanich Peninsula. Scattered individuals and groups of fruit trees were also severely attacked from Sidney to Victoria and the western communities. This introduced pest has caused serious defoliation of deciduous trees, primarily Garry oak, for more than 15 years on southern Vancouver Island.

A program of biological control was initiated in the Greater Victoria area in 1979 and is being considered for the mainland in 1990. Defoliation of ornamentals can be reduced by applying a sticky barrier, (e.g., Tanglefoot) to tarpaper bands around tree trunks in mid-October. The barrier prevents the flightless females from crawling up the trunk to lay eggs. Leave the barrier in place until mid-January.

Western tent caterpillar
Malacosoma californicum pluviale

Populations of this colonial defoliator have remained at endemic levels for the last three years after four consecutive years of severe defoliation. Isolated individual colonies were visible in various parts of the Region on deciduous trees and shrubs. Historically, populations have remained at low levels for approximately five years after infestations subside.

Forest tent caterpillar
Malacosoma disstria

Low populations of the forest tent caterpillar caused trace to moderate defoliation of scattered single deciduous trees east of Bella Coola mainly along Nusatsum River. Historically, populations have remained at low levels for several years before building up. Severe defoliation over 2-3 years can cause top and branch-dieback on deciduous trees.

A bud midge
Dasineura n. sp.

For the fourth consecutive year this bud midge continued to kill black cottonwood buds on the southern coast and on Vancouver Island. Bud mortality caused by the midge was first reported in 1988 and has spread very quickly since.

Top-kill and some tree mortality were evident on seedlings and saplings at various sites along the lower Fraser River below Hope and at several locations on Vancouver Island. Up to 100% of naturally regenerated cottonwood was attacked with all new buds killed. So far, no reports have been made of the bud midge infesting exotic poplars. Surveys for this pest will continue in 1990.

An oak leaf phylloxeran
Phylloxera sp. nr. glabra
and
Jumping gall wasp
Neuroterus saltatorius

Reports of premature browning, scorching or defoliation of Garry oak increased sharply in 1990. This damage is caused by either of two insects: an **oak leaf phylloxeran** (an aphid-like sucking insect), Phylloxera sp. nr. glabra, or the **jumping gall wasp**, Neuroterus saltatorius. Most of the increased damage apparent in Greater Victoria was caused by the jumping gall wasp.

The present damage on oaks is not to be confused with the extensive and widespread defoliation caused by the winter moth, Operophtera brumata, during the 1970s and early 80s. Winter moth defoliation occurs in May-June and is not preceded by browning or scorching of foliage. Following successful parasite releases from 1979-81, winter moth defoliation has generally declined to very low levels. At present, localized defoliation of Garry oak by winter moth is occurring only in the Lansdowne area of Oak Bay.

Damage caused by these insects can be readily distinguished by examining the lower surface of affected foliage - phylloxeran-injured leaves are covered with numerous minute orange insects resembling aphids, while foliage affected by the jumping gall wasp have large numbers of small, 1.0- to 1.5-mm round galls attached to the leaf.

The oak leaf phylloxeran is an European insect and has been known in the Victoria area since the mid 1950s. Garry oak and, rarely, English oak are attacked. In North America, this insect is known to occur only on Vancouver Island from Nanaimo south to Victoria.

Phylloxeran damage to individual trees is generally more serious than that of the jumping gall wasp since the same trees are repeatedly defoliated over many years, gradually weakening the host tree. Typically, phylloxeran-damaged trees turn completely brown by mid-to-late July; the dead leaves drop shortly thereafter. Many defoliated trees produce a second flush of leaves which remain green into November. The same trees are preferentially attacked each year with very little spread to other nearby oaks. Trees under attack for several consecutive years are visibly weakened with many dead branches, weak growth and poor foliar development. It is not certain at this time if the oak leaf phylloxeran is entirely responsible for the decline or if trees stressed by other factors are preferentially attacked. However, continued defoliation will likely accelerate the decline. At present, about 10% of the Garry oaks in the Greater Victoria area are affected. Damage reported here is much more severe than in Britain, where only an occasional oak is affected in some years.

At present, no viable chemical control options are available as affected trees are usually very large and are located in urban areas. Small high value trees could be sprayed with dormant oil in winter to kill overwintering eggs or, alternately, in spring (early May) with summer oil to kill newly emerged nymphs. As oak leaf phylloxera is not considered to be a serious pest in Britain, chemical or biological controls have not been developed there. Cultural remedies such as irrigation and fertilization may help reduce attack and improve tree vigor.

The jumping gall wasp is native to western North America but has only recently become abundant in the Greater Victoria area where damage reports have increased steadily over the last five years. Early damage reports in 1986-87 were centered mainly in the View Royal - Mill Hill area. Since then, the infestation has spread to include a broad area from Langford Lake in the west through parts of Colwood, Langford, View Royal, Esquimalt, south and west Saanich to Brentwood Bay. Damage has not been reported in Victoria or north of Brentwood Bay.

Individual trees affected by jumping gall wasps generally are not scorched or defoliated as severely as is the case with the oak leaf phylloxeran. On most trees, 20 - 60% of the foliage is scorched but damage may range from light speckling to almost complete scorching of foliage and defoliation. Virtually every tree within an infested area may have some damage.

The local outbreak pattern in which almost every tree is attacked over a steadily expanding area is more severe than reported in the United States where typically only an occasional widely scattered oak is attacked in some years. Rearing of galls by the Pacific Forestry Centre in 1990 indicate a very low

(3-15%) level of parasitism. Therefore, continued damage with possible expansion of the area under attack is expected in 1991. Increased levels of parasitism in the future should reduce jumping gall wasp damage.

This section of the report was submitted by Robert Duncan, FIDS biologist.

Fall webworm
Hyphantria cunea

Populations of this common defoliator of hardwood trees increased for the second consecutive year in the Chilliwack and Agassiz areas and on southeastern Vancouver Island this year. Webworm tents were common on walnut, willow, alder, poplar and various fruit trees.

In severe infestations, larvae may defoliate entire trees. Branches bearing webs can be cut off and the colonies burned. Insecticides registered for use against leaf-chewing insects should be effective if sprayed on the feeding areas, particularly if applied about the time the young caterpillars are spinning tents in early summer.

Poplar and willow borer
Cryptorhynchus lapathi

For the second consecutive year this European weevil attacked willow and poplar throughout the hosts' range in the Vancouver Region. Dead, and dying willow, and to a lesser extent poplar, were evident, mostly along road sides, from Yale and Pemberton in the north to Vancouver in the south.

This pest does not always kill the plant but causes dieback and multiple tops. Larval feeding weakens the stems, making them susceptible to breakage during high winds and snowfalls, which is more of a concern in ornamental plantings. Infestations have been recorded periodically in southern British Columbia since 1930.

Birch leafminers
Fenusa pusilla
and
Profenusa thomsoni

These two introduced leafminers reached epidemic levels on birch throughout Greater Vancouver and the lower Fraser Valley.

Leafminer damage was evident in most natural stands of birch in the Fraser Valley and on ornamental birch in Vancouver. Limited surveys made it difficult to determine which leafminer caused the most damage but both species were very common and both appeared on the same trees in several areas. Blotched and wrinkled foliage and then premature browning was widespread throughout the infestation areas. As white birch is not a commercial tree species on the coast and is usually considered a weed, control may not be necessary or even desirable.

Broadleaf maple dieback

The intensity and area of broadleaf maple dieback or leaf scorch increased throughout the host range in the Region. No common denominator has yet been identified as to why some trees are affected and others are not. Trees of all age classes on all aspects and sites are affected, it is common to see apparently healthy trees growing beside a tree with 100% of the foliage discoloured.

The amount of affected foliage was also widely different from tree to tree and site to site with as little as 5% of foliage scorched on some trees and 100% on others. Early discoloration was also noted this year with affected trees observed in early June while in past years the damage was not seen until July.

The cause of the dieback is still unknown. In the eastern United States, a fastidious, xylem-inhabiting bacterium was found to be causing similar damage in red maple, Acer rubrum. Tests using the electron microscope to determine if a similar organism is involved here are underway.

Dogwood leaf blight
Discula (=Gloeosporium) sp.

Defoliation of western flowering dogwood by this leaf blight fungus increased this year throughout the host range. This blight has been a common and chronic problem for almost a decade in the Region, causing branch dieback and some mortality. Infections were widespread throughout the Region from Spuzzum to Vancouver and over much of the southern half of Vancouver Island, ranging from 5 to 80% defoliation with heavier infections occurring on the more shaded trees. The increased intensity of infections noted this year can be attributed to the wet spring that created the suitable conditions for the spread of the disease. A drier spring in 1991 could decrease the level of infection as will the burning of infected leaves and branches this winter.

MINOR PESTS

Collections and records were made of many pests currently at endemic levels (Table 11). These pests include Swiss needle cast, western gall rust, spruce budmoth, green-striped forest looper and other insects and diseases.

Table 11. Pests currently at endemic levels, Vancouver Forest Region, 1990.

Pest	Host	Location	Damage	Status
Green-striped forest looper, *Melanolophia imitata*	D-fir	Lower Mainland	increased numbers of larvae	endemic
Phantom hemlock looper, *Nepytia phantasmaria*	D-fir	Lower Mainland	low numbers of larvae collected	endemic
Pine butterfly, *Neophasia menapia*	D-fir	Vancouver Region	none	endemic
Silver spotted tiger moth, *Lophocampa argentata*	D-fir	Vancouver Region	single scattered colonies	static
Swiss needle cast, *Phaeocryptopus gaeumannii*	D-fir	Vancouver Region	scattered light defoliation throughout region	endemic
Western gall rust, *Endocronartium harknessii*	lP	Vancouver Region	infection as high as 90% in scattered areas common	endemic
Spruce budmoth, *Zeiraphera* sp.	sS D-fir aF	Vancouver I. QCI	light defoliation in scattered patches on the west coast and QCI	endemic
Dwarf mistletoe, *Arceuthobium tsugense*	wH	Vancouver Region	widespread	endemic
Cypress tip moth, *Argyresthia* sp.	Ornamental juniper, cedar and cypress	Vancouver I.	light damage of foliage at several widespread locations	static
Cypress twig mite, *Trisetacus chamaecypari*	yC	Vancouver Region	widespread in most yellow cedar stands	increasing

Pest	Host	Location	Damage	Status
Larch sawfly, *Pristiphora erichsonii*	wL	Lower Mainland	scattered light defoliation at U.B.C. Research Forest and Stanley Park	static
Alder flea beetle, *Altica ambiens*	aL	Vancouver Region	scattered patches of severe widespread defoliation	increasing
Canker disease, *Dermea balsamea*	wH	Graham Island	light infection of branches over 10 ha	static
Hemlock adelgid, *Adelges tsugae*	wH	Vancouver Region	low-high populations widespread	static
Large-spored spruce - Labrador tea rust, *Chrysomyxa ledicola*	sS	Vancouver and QCI	several isolated locations	static

D-fir - Doulas-fir
lP - lodgepole pine
sS - Sitka spruce
aF - amabilis fir
wH - western hemlock
yC - yellow cedar
wL - western larch
aL - alder

NEW RECORDS OF OCCURRENCE AND DISTRIBUTION

A total of 15 disease collections in 1990 were new host records in the Vancouver Forest Region. Most of the new disease records were relatively minor foliage or bark disorders and some saprophytes. Eight collections were on deciduous hosts, four on conifer hosts and herbaceous plants.

****